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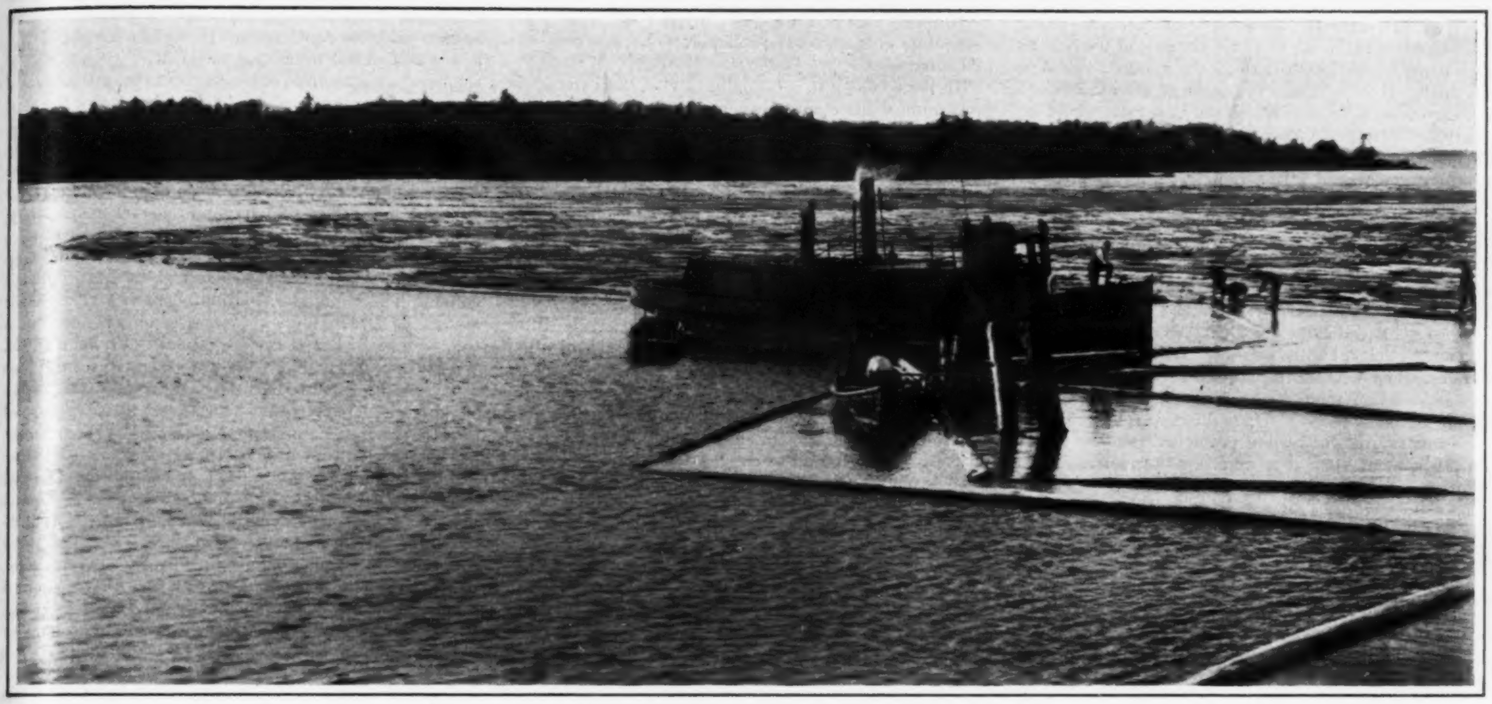


Floating a boom of old ties down the river.

Place where rubble is deposited for cofferdam. The dredge in the background is filling the interior of the cofferdam.

THE RAINY LAKE FILL.—[See page 216.]

# Some Facts and Problems Regarding Our Atmosphere*

## What Soundings Have Taught and What Still Remains to be Learnt

By Alexander McAdie

The thickness of the Earth's atmosphere, compared with the diameter of the Earth, is as a sheet of tissue paper to the thickness of a good-sized book. Compared with the Sun's diameter, the ratio would be tissue paper to one hundred volumes; or to the distance of the Sun, as tissue paper to one hundred times the hundred volumes; and, finally, if we compare the depth of the atmosphere with the distance to the nearest star, the ratio would be something like a sheet of paper to thirty-six hundred rows of books, each row containing a million volumes. Plainly, astrometry, compared with aerometry, is as the great to the small; and one might hastily infer that our atmosphere is a negligible quantity. Yet the greater is sometimes dependent on the less, and from astronomers themselves we gather that they have their troubles due to the Earth's atmosphere; for did not the President of the Royal Astronomical Society, speaking at the annual dinner of the Royal Meteorological Society not long ago, say, half jocularly, half in earnest, that the "ideal world of the astronomer would be a world in which no atmosphere existed and there were no science of meteorology and no meteorologists"? Undoubtedly, this would be the easiest solution of certain problems from the astronomical point of view, if it were not that astronomers, like other people, must live.

It was in California, it will be remembered, that an early attempt was made to free the astronomer from some of his troubles due to dust-laden atmosphere and the aberration of the image by non-homogeneous air strata. In the history of the Lick Observatory, we have a striking illustration of increased efficiency due, in part, to favorable atmospheric environment. Again, at the Mt. Wilson Solar Observatory, an institution devoted specially to the study of the one near star, our Sun, the necessity of a pure and steady atmosphere has been shown to be all-important. The latter observatory and the Smithsonian Astrophysical Observatory have, through unusual atmospheric opportunities, virtually developed a new field of research, one as yet without a name and for which until a more appropriate name shall be given we propose "solclimatics," asking forgiveness for the violence done our mother tongue.

In this field, where research practically began with Langley's work in determining the value of the solar constant and the coefficients of absorption for various radiations, checked by his observations at Mt. Whitney, such questions as the relation of seasonal abnormalities of pressure and temperature, precipitation with variation in the solar output, and, in brief, all questions relating to climate control by variation of solar output, will call for co-operative work by aero-physicist and astronomer. The former must furnish whatever data are required relating to air movement, the absorption and radiation of heat at various levels in the atmosphere, and the departures due to the presence of water vapor. Nor can the aerologist longer content himself with assumed conditions and employ formulæ and equations of limited application. He must deal with the atmosphere as it is; that is, as modern exploration is showing it to be, a non-adiabatic atmosphere and not a dry, pure perfect gas.

At this point, reference may properly be made to the units now coming into use in aerological work. In the *Monthly Weather Review* for August, 1908, there appeared a paper by McAdie on the need of more rational units in aerology; and giving an original method of recording pressure variations in percentages or permillages of a standard atmosphere. The paper was extensively commented upon and aroused much discussion. In the *Monthly Weather Review* for March, 1909, Dr. W. Koppen, Director of the Deutsche Seewarte at Hamburg, pointed out that if pressure were measured in bars or millibars, as employed by Bjerknes, Sandstrom, and others, the advantages of the percentage system proposed by McAdie would be realized, with the additional gain that all pressures would be expressed in dynamic units. In other words, Koppen's proposal was to use, instead of sea-level pressure, the pressure normally found at a height of 348 feet, or 106 meters. This would change, then, from the former barometric standard of 29.92 inches, or 760 millimeters (at latitude 45 deg), which in force units would be 1,013,303 dynes, to the even 1,000,000 dynes, corresponding to reading 29.53 inches, or 750 millimeters. Dr. Koppen also presented to the Aerological Congress at Monaco in April, 1909, a strong plea for the use of dynes. During 1909 and 1910, the writer urged the adoption of these units by the U. S. Weather Bureau, but without success. In the *American Journal of Science* for October, 1910, and in other publications he has shown the advantages resulting from the adoption of these units. In 1910 there was published by the Carnegie Institution the first volume of "Dynamic Meteorology and Hydrography," by the well-known investigator, V. Bjerknes and collaborators. Bjerknes significantly says:

"In meteorology it is common to give the barometric pressure in millimeters or inches of mercury. The millimeter division is not in the least more rational than the division into inches. Neither of them has anything to do with absolute units. The consequences of this irrationality have not yet been severely felt because the barometric records have until now served for qualitative purposes mainly."

So far as known to me, no actual use of the new units (pressure in millibars and temperature in degrees absolute Centigrade) was made in the United States except by the writer, at San Francisco in the period 1909–1913.[1] In Europe, under the progressive leadership of such eminent meteorologists as Koppen, Shaw, Assmann, Dines, Gold, Cave, and others, the units have come into general use. Daily and weekly weather reports give pressure in millibars.[2] On January 1st, 1914, the U. S. Weather Bureau began to employ these units in a daily weather map of the northern hemisphere. The following table, devised at Blue Hill Observatory, has been found convenient and may be helpful in astronomical observatories where pressures are still read in inches and fractions thereof. Copies of these conversion tables and similar tables for converting readings in millimeters may be obtained from the Director of the Blue Hill Observatory of Harvard University. In this table, the first column gives the height of the barometer, in inches, for every tenth of an inch from 29.0 to 31.0. The second column gives the corresponding pressure in millibars when 1,000 is added. The remaining columns give the pressures in millibars at intermediate heights at intervals of 0.02 inch. It is to be remembered that the base is no longer sea-level, but altitude 106 meters.

BASE PRESSURE 1,000,000 DYNES OR 1,000 MILLIBARS.
Pressure in millibars = 1,000 +.

| Barometer in inches. | .00 | .02 | .04 | .06 | .08 |
|---|---|---|---|---|---|
| 29.00 | −18.0 | −17.3 | −16.6 | −16.0 | −15.3 |
| 29.10 | −14.6 | −13.9 | −13.2 | −12.6 | −11.9 |
| 29.20 | −11.2 | −10.5 | − 9.9 | − 9.2 | − 8.5 |
| 29.30 | − 7.8 | − 7.2 | − 6.5 | − 5.8 | − 5.1 |
| 29.40 | − 4.4 | − 3.8 | − 3.1 | − 2.4 | − 1.7 |
| 29.50 | − 1.1 | − 0.4 | + 0.3 | + 1.0 | + 1.7 |
| 29.60 | + 2.3 | + 3.0 | + 3.7 | + 4.4 | + 5.0 |
| 29.70 | + 5.7 | + 6.4 | + 7.1 | + 7.7 | + 8.4 |
| 29.80 | + 9.1 | + 9.8 | +10.5 | +11.1 | +11.8 |
| 29.90 | +12.5 | +13.2 | +13.8 | +14.5 | +15.2 |
| 30.00 | +15.9 | +16.6 | +17.2 | +17.9 | +18.6 |
| 30.10 | +19.3 | +19.9 | +20.6 | +21.3 | +22.0 |
| 30.20 | +22.6 | +23.3 | +24.0 | +24.7 | +25.4 |
| 30.30 | +26.0 | +26.7 | +27.4 | +28.1 | +28.7 |
| 30.40 | +29.4 | +30.1 | +30.8 | +31.5 | +32.1 |
| 30.50 | +32.8 | +33.5 | +34.2 | +34.8 | +35.5 |
| 30.60 | +36.2 | +36.9 | +37.5 | +38.2 | +38.9 |
| 30.70 | +39.6 | +40.3 | +40.9 | +41.6 | +42.3 |
| 30.80 | +43.0 | +43.6 | +44.3 | +45.0 | +45.7 |
| 30.90 | +46.4 | +47.0 | +47.7 | +48.4 | +49.1 |
| 31.00 | +49.7 | +50.4 | +51.1 | +51.8 | +52.4 |

Example: Barometer reading 29.62 inches, convert to millibars. Tabular correction for 29.60 + .02 is +3.0. Pressure in millibars is 1,000 + 3.0 = 1,003.0.

Beginning with the familiar equation connecting pressure, $P$, volume, $V$, temperature, $T$, and gas constant, $R$,

$$PV = RT,$$

the height of the so-called homogeneous atmosphere, that is, the thickness of the stratum which our entire atmosphere would form if compressed to a uniform density equal to the average density at the base level (106 meters above sea) and at temperature zero Centigrade (= 273 deg. Abs.), can be found thus, in meters:

$$\frac{13.596 \times 0.750}{0.001293} = 7886;$$

the three numerical factors being, in order, the density of mercury, the pressure reading, and the specific weight of air. We may call the value approximately 8,000 meters. The gas constant $R$ is obtained by dividing by 273. If pressures are given in millibars, the value of $R$ is $2.87 \times 10$. But these values are for dry air and need further correction. The volume of the atmosphere is approximately $4.080 \times 10^{15}$ cubic meters; or, since a cubic meter of dry air at 273 deg. Abs. and standard gravity weighs 1,293 kilogrammes, the weight of the atmosphere in round numbers is $5,200 \times 10^{15}$ kilogrammes. This is about 1/1,125,000 of the Earth's mass.

If we determine the approximate height of the sensible atmosphere by the disappearance of the twilight arch (18 degrees below the horizon) we have Earth's radius multiplied by the secant of 9 degrees, less 1, or $h = R$ $(1.0125 - 1) = 0.0125 \times 6{,}370{,}191$ meters $= 79{,}627$ meters. This must be corrected for refraction, and the final value would be about 64,000 meters, or eight times the depth of the homogeneous atmosphere. As we have already said, the depth of the atmosphere compared with any astronomical dimension is no more than a leaf of thinnest paper to miles of books. Still the instruments of the astronomer are emplaced in this paper. For the most part, they are at the very bottom of the atmosphere. True, in some States, as in California and Arizona, instruments are used at high levels. At Mt. Wilson and Pasadena comparative work can be done at levels of 1,493 dynamic meters and 247 dynamic meters, respectively; in other words, through a range of one fifth of the effective atmosphere. And it is feasible to work an appreciable part of the year at elevations as high as 4,500 dynamic meters. The summit of Mt. Whitney is at 4,329 dynamic meters, or 4,419 meters above sea-level, where the pressure is but 0.6 that at the basal plane. St. John of Mt. Wilson has shown that there are several spectrum lines which are displaced in measurable degree by a difference of pressure of two tenths of an atmosphere. The point is referred to only to show that the atmosphere cannot be disregarded in ultimate determinations of wavelengths, frequencies of vibration, and standards of length.

The most important outcome of recent exploration of the air by kites and sounding balloons is the establishment of the two great layers which are best known by the names troposphere and stratosphere. Theoretically, when dry air is lifted to a level where the pressure is reduced one half, there should be a cooling of 50 deg. Cent. In fact, and especially near mountain peaks, very different results are found. But even the adiabatic rate does not hold. This we shall return to later.

Numerous records of soundings have been published by the International Commission for Scientific Aerostation. We give one of the latest records made at the observatory at Uccle, Belgium, June 9th, 1911, during pleasant weather. A height of 31,780 d. meters (32,430 meters) was reached. The lowest temperature was given by one thermometer (Hergesell) as 212 deg. Abs. (−61 deg. Cent.) at 13,040 meters, while the balloon was rising, or 213 deg. Abs. by the other thermometer (Kleinschmidt) at 12,600 meters, while the balloon was descending.

The following skeleton table may be interesting:

| Time | Pressure. | | Elevation. Met. | Temperature, Abs. Deg. | Gradient. | R. H. |
|---|---|---|---|---|---|---|
| | Mb. | Mm. | | | | |
| 7:00 | 1,001 | 751 | 100 | 290 | .... | 81 |
| 7:05 (?) | 900 | 675 | 1,000 | 287 | .... | .. |
| .... | 797 | 598 | 2,000 | 281 | .056 | .. |
| .... | 705 | 529 | 3,000 | 275 | .066 | 51 |
| 7:18 | 621 | 466 | 4,000 | 269 | .042 | 34 |
| 7:20 (?) | 547 | 410 | 5,000 | 264 | .069 | .. |
| .... | 479 | 359 | 6,000 | 251 | .086 | 30 |
| 7:34 | 313 | 235 | 9,000 | 234 | .084 | 30 |
| 7:38 | 271 | 203 | 10,900 | 222 | .065 | .. |
| 7:44 | 199 | 149 | 12,000 | 216 | .039 | 29 |
| 7:47:04* | 168 | 126 | 13,040 | 213 | .021 | 29 |
| 7:48 | 160 | 120 | 13,340 | 213 | −.007 | 29 |
| 7:52 | 129 | 97 | 14,650 | 218 | −.031 | 30 |
| 7:56 | 103 | 78 | 16,050 | 223 | −.07 | 29 |
| 8:02 | 72 | 54 | 18,370 | 218 | .01 | 29 |
| 8:12 | 36 | 27 | 22,720 | 222 | .00 | 29 |
| 8:32 | .8 | 6 | 32,430 | 234 | .... | 29 |

* Beginning of Inversion.

The adiabatic gradient generally employed is 9.87 deg. Cent. per kilometer. For 5.5 kilometers, therefore, the fall in temperature would be about 54 degrees. But the rate holds only for small changes; and, as Dines[3] has pointed out, the formula "in fact is only true for the supposed case of convective equilibrium which, so far as dry air is concerned, never exists in practice for any large change of height." He gives the following departures for different heights, assuming average conditions:

| Kilometers. | Centigrade Degrees. | Kilometers | Centigrade Degrees. | Kilometers. | Centigrade Degrees. |
|---|---|---|---|---|---|
| 1 | 0.3 | 6 | 3.5 | 11 | 11.3 |
| 2 | 0.6 | 7 | 4.5 | 12 | 13.9 |
| 3 | 1.0 | 8 | 6.0 | 13 | 16.7 |
| 4 | 1.8 | 9 | 7.6 | 14 | 19.8 |
| 5 | 2.6 | 10 | 9.7 | 15 | 25.0 |

Temperature, then, does not fall as rapidly as the law requires and the pressure at a given level is greater than that given by formula. Bigelow[4] shows that the gas coefficient $R$, while a constant in the adiabatic system, is a variable in the non-adiabatic system. In other words, the specific heat is a variable in non-adiabatic air. This means that no account is taken of circulation or of radiation of heat. He very properly says that "the gravity, pressure and circulation terms, as computed

*Presidential address delivered before the Astronomical Society of the Pacific.

[1] *Scientific American Supplement*, December 6th, 1913.

[2] *Nature*, October 16th, 1913.

[3] *Quar. Jour. R. Met. Soc.*, July, 1913, Vol. XXXIX, No. 167, page 187.

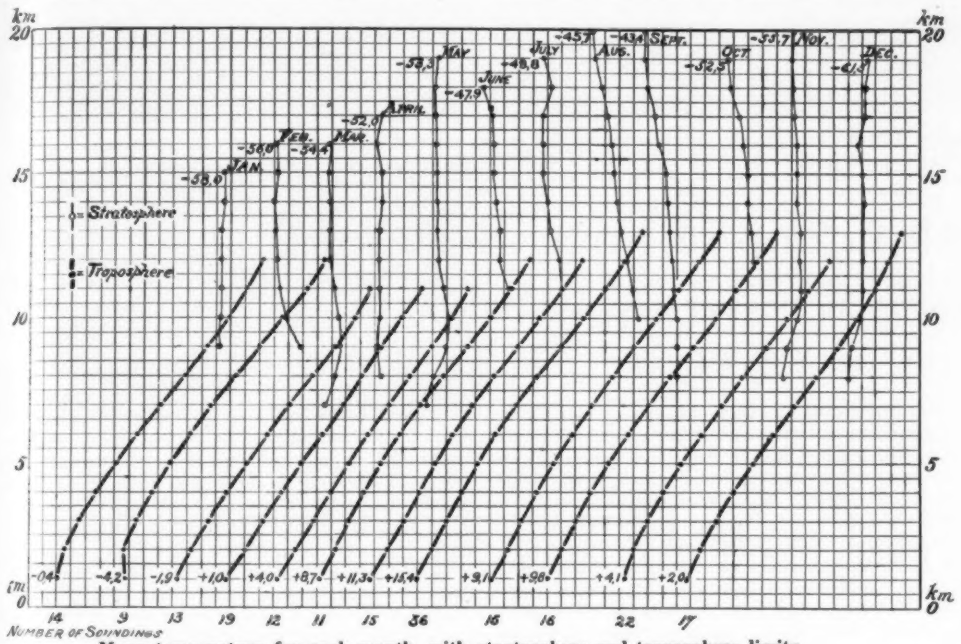
[4] *American Journal of Science*, Vol. XXXIV, December, 1912.

from the observations in cyclones, anti-cyclones, and in the general circulation, do not conform; and all the efforts of meteorologists to make them do so have been failures or fictitious and improper solutions."

From the results of nearly two hundred soundings made during 1906–08, Nadler has summarized the mean temperature at various levels for each month and also the average limits of the troposphere and stratosphere. (See diagram.[5])

What precedes shows that a ray of light traversing the atmosphere does not come through a homogeneous medium nor through one of uniformly decreasing density. This must materially affect the values of the coefficients of refraction as ordinarily given. As to measuring the heights of mountains by vertical angles (theodolites), it is interesting to know that other methods presumably less accurate have given truer heights. Thus, in measuring the heights of Mts. Whitney, Shasta, and Rainier, the results obtained by the writer, using atmospheric pressure methods, were nearer the true elevations than those obtained with theodolites by the engineers. Again, in measuring the high peaks of Asia (to which Prof. E. C. Pickering has called my attention) the British geodesists found that all angles of elevation to high peaks, measured from the plains of India and from the outer hills, were too large. This is strikingly shown in the case of Mt. Everest, where all measurements from low-lying stations make the mountain over 30,000 feet, while all measurements from the high levels make the mountain less than 30,000 feet. Refraction is the cause of the difference, and coefficients suitable for low levels are not accurate for high air work. According to Burrad and Hayden, refraction is greatest in the morning and evening and least in the middle of the day. It is different in summer from winter.

[5]The figures beneath the diagram (*Anz. d.* and *Aufst.*) indicate the number of soundings upon which each monthly curve is based. The figures at the right and left express the altitude in kilometers, and those on the diagram itself, the temperatures in degrees Centigrade. For example, 15 sounding balloon ascensions in July gave average temperature of +11.3 deg. Cent. at altitude one kilometer. The temperature decreased up to altitude 12 kilometers, and then remained almost constant, or increased slightly to altitude 19 kilometers, temperature —48.8 deg. Cent.




**Mean temperature for each month, with stratosphere and troposphere limits.**

From G. Nadler, in *Breiträge zur Physik der freien Atmosphäre.*

Tucker, in *Lick Observatory Bulletin*, No. 231, has discussed the diurnal variation in the refraction at Mt. Hamilton, using observations for a period of nearly twenty years. He finds a slight but distinct difference between the refraction effect in the daylight and night hours that does not depend upon the pressure temperature, or change of temperature during the observing hours. He suggests that the physical explanation may lie in the rapid changes in the surface strata as compared with slower changes in higher levels near the time of sunrise and sunset, so that the readings of the thermometers in the air strata near the Earth's surface are not representative of the temperatures in overlying strata. Evidently soundings of the atmosphere near Mt. Hamilton might show frequent and marked inversions of temperature.

Again, there are many questions connected with the transparency of the air. For example, the successful use of the photo-electric cell, which promises so much in photometric measurements, must be affected by any rapid variations in air transparency. Can the aerophysicist be of service to the astro-physicist in this rapidly developing field?

Meteorology had its beginning under the sheltering domes of astronomy. Although men live in the air, they seem to have been interested more in the motions of the stars than in the movements of the medium in which they lived. After many years of waiting came the Burgomaster of Magdeburg, with his air-pump; then Galileo, inventor of thermometer as well as telescope; and after him Torricelli, with the barometer. What instruments are we still waiting for that shall help us to a better understanding of this envelope of gases and water-vapor, relatively small in itself, but meaning so much to the development of astronomy?

## Safety of Life at Sea*

### Regulations for Subdivision of Hulls

The International Convention on Safety of Life at Sea has recommended a number of detailed regulations governing the construction of ships and dealing with such matters as the length of watertight compartments, the arrangements in connection with watertight doors and the provision for double bottoms.

As regards compartments, their length is determined by multiplying the floodable length of the ship by a "factor of subdivision," which depends on the length of the ship and, for a given length, varies according to the nature of the service for which the ship is intended. It decreases regularly and continuously (*a*) as the length of the ship increases, and (*b*) as, for a given length, the ship departs from the type engaged in mixed cargo and passenger service and approaches the type primarily engaged in the carriage of passengers. In no case must a compartment be longer than 92 feet. When the length of a ship exceeds 699 feet, but is less than 823 feet, the floodable length at the forward end must be at least 20 per cent of the ship's length; and the ship, forward of a bulkhead placed either at the distance of the actual floodable length abaft the stem, or not nearer the stem than 20 per cent of the ship's length, must be divided into at least three compartments. If the ship's length is 823 feet or more, the floodable length must be at least 28 per cent, and the number of compartments at least four. The floodable length for a given point in a ship with a continuous bulkhead deck is defined as the maximum percentage of the length of the ship (having its center at the point in question) which can be flooded under certain assumptions set forth in Article VII., without the ship being submerged beyond the margin line, the latter being a line drawn parallel to the bulkhead deck at the side line and 3 inches below the upper surface of that deck.

BULKHEAD CONSTRUCTION.

A forepeak bulkhead extending to the bulkhead deck and to the weather deck in ships having continuous superstructures, is to be placed at a distance of not less than five per cent of the ship's length from the stem at the load line. An afterpeak bulkhead and bulkheads dividing the machinery space from the cargo and the passenger spaces must also be fitted and carried up to the bulkhead deck, but the afterpeak bulkhead may be stopped below the bulkhead deck, provided that it be carried at least to the first deck above the load waterline, and that that deck forms a watertight flat from the afterpeak bulkhead to the stern, and provided also that the degree of safety of the ship as regards subdivision is not thereby diminished.

Fireproof bulkheads, to retard the spread of fire, are to be fitted in parts of a ship above the margin line, the mean distance between them not to exceed 131 feet.

Watertight bulkheads are to be capable of supporting, with a proper margin of resistance, the pressure due to a head of water up to the margin line. The testing of main compartments by filling them with water is not compulsory, but the foremost and aftermost compartments must be tested with water to a head up to the margin line, and double bottoms, deep tanks and all compartments intended to hold liquids must be tested with water to a head 8 feet above the top of the tank or to the load water line, whichever is the greater. So far as practicable, all provisions relating to main transverse watertight bulkheads apply to longitudinal bulkheads.

DOORS AND OPENINGS.

The number of openings in watertight bulkheads must be as small as possible compatible with the design and proper working of the ship, and the openings must be provided with proper means of closing. Doors, sluice valves, manholes and access openings are prohibited in the collision bulkhead below the margin line and in watertight transverse bulkheads dividing a cargo space from an adjoining cargo space or from a reserve bunker. Hinged watertight doors of specially heavy design may, however, be fitted above the load water line in bulkheads between cargo 'tween-deck spaces, but they must be closed before the voyage begins and must be kept closed while at sea by efficient gear.

The only types of watertight doors permissible are hinged, sliding and doors of any other equivalent pattern, excluding plate doors secured only by bolts. Hinged doors must be fitted with lever-operated catches workable from each side of the bulkhead. Sliding doors may have vertical or horizontal motion. If hand-operated only, a door must be capable of being operated at the door itself and also from an accessible position above the margin line. If operated by power it must be capable of being operated from the bridge and by hand both at the door itself and from an accessible position above the margin line. A door dropping by its own weight and fitted with a cataract cylinder or equivalent arrangement may be considered as operated by power if capable of being released from the bridge. Hinged watertight doors in passenger, crew and working spaces are only permitted above a deck, the under side of which, at its lowest point at side, is at least 7 feet above the load water line, and they are not permitted in those spaces below such deck. All other watertight doors must be sliding doors. When the number of watertight doors in the main transverse watertight bulkheads at or above the stokehold level in the machinery space exceeds five, excluding the watertight doors at the entrances of tunnels, all the watertight doors below the load water line must be capable of being simultaneously closed from a station on the bridge. All watertight doors must be kept closed during navigation, except when necessarily opened for the working of the ship, and must always be ready to be immediately closed.

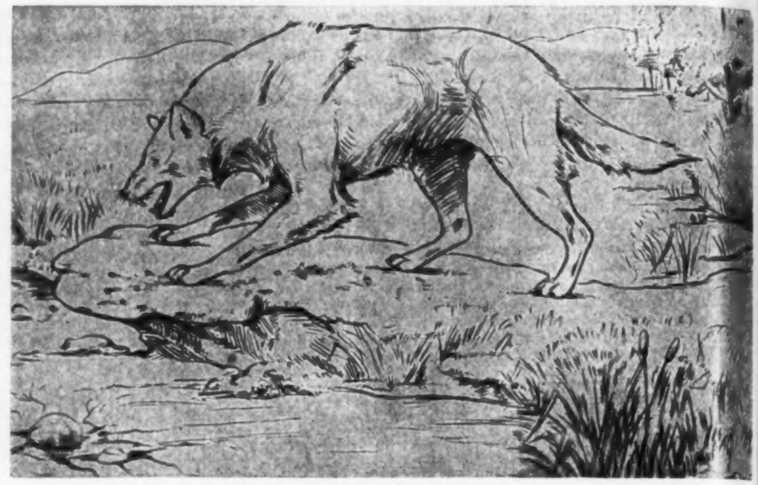
DOUBLE BOTTOMS.

The regulations require double bottoms to be fitted at least from the machinery space to the forepeak bulkhead in ships between 200 feet and 249 feet in length; and at least outside of the machinery space and extending to the fore and after peak bulkheads respectively in ships between 249 feet and 300 feet in length. In ships 300 feet long or more, a double bottom must be fitted amidships and extend to the fore and after peak bulkheads, and the inner bottom must be extended out to the ship's sides in such a manner as to protect the bridges. For ships over 699 feet long it is required that the double bottom, for at least half the ship's length amidships and forward to the forepeak bulkhead, shall extend up the ship's sides to a height above the top of the keel not less than 10 per cent of the ship's molded breadth.

* Reproduced from the London *Times*.

**Scientific Results of Scott's Antarctic Expedition.**—The work of elaborating and preparing for publication the scientific data collected by the British Antarctic Expedition of 1910–1913 is now actively in progress under the direction of a committee of three, appointed to administer the sum of £17,500 set aside for this purpose from the Mansion House fund raised by popular subscription for the relief of survivors and other expenses of the expedition. The committee consists of Sir Archibald Geikie, representing the Royal Society; Major Leonard Darwin, representing the Royal Geographical Society; and Staff-Surgeon Atkinson, R.N., representing the scientific staff of the expedition; with Capt. H. G. Lyons, F.R.S., as secretary.

Restoration of the saber-tooth tiger (Smilodon californicus) by Erwin Christman. A ground sloth (Mylodon) is nearly submerged in the asphalt pool.



Restoration of the extinct wolf (Canis dirus) by Erwin Christman. Asphalt pool in foreground with a bursting gas bubble.

# The Asphalt Group of Fossil Skeletons*

## At the American Museum of Natural History

By W. D. Matthew

THE TAR-PITS OF RANCHO-LA-BREA, CALIFORNIA

The Museum has recently completed and placed on exhibition a group to illustrate one of the most marvelous fossil deposits of the world. This is the famous asphalt formation of Rancho-la-Brea near Los Angeles, Cal.

The petroleum of Southern California, as in most of the West, has an "asphalt base"; that is to say, when it evaporates, the heavy oils left behind are asphaltum instead of paraffin. Wherever the petroleum oozes up from the earth in springs, this residuum of asphalt accumulates. The oil wells up continually from below and keeps it soft close around the spring, but elsewhere it is hardened into a solid mass mixed with earth or wind-blown dust. At the Rancho-la-Brea, in the center of a broad open valley close to the city, is an extensive formation of this sort, made by oil springs which were probably much more active in former times than now. Here and there, on the surface, are little pools of semi-liquid asphalt, covered with a film of dust in dry weather, with water after a rain, yielding slowly beneath the weight and clutching with unbelievable tenacity whatever sinks beneath the surface. To the inexperienced eye, the dust-covered surface looks like firm ground; except in the softer pools, one can walk across it without any considerable yielding. But woe to the unfortunate animal that steps into one of the softer pools, or lingers on his way across a firmer surface to look about him or to drink of the water collected over the asphalt surface. His feet sink below the surface, the treacherous tar clutches them fast, and his most desperate struggles result only in sinking him deeper and deeper. Escape is impossible; he succumbs finally to exhaustion, and little by little is sucked down and disappears.

Such has been the fate of many small animals in the last few years. Larger animals, too, cattle, horses and dogs have been caught in the asphalt, some dragged out by the aid of ropes, while others not seen in time for rescue, have perished miserably. But the tar-pits, although cruelly effective to the limit of their size, are not now large or numerous enough to constitute a serious danger.

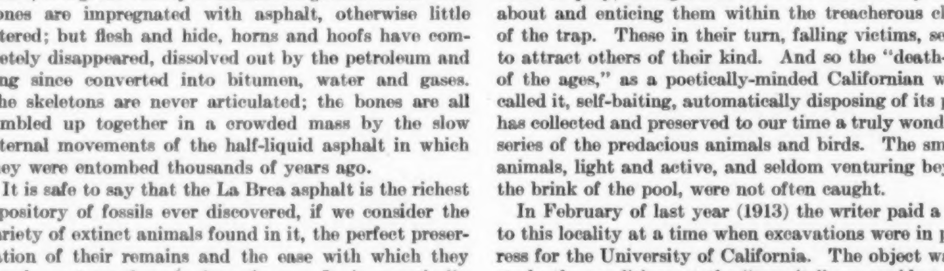
At the time when these springs were active, the asphalt pools were much larger and more numerous, and formed a death-trap of terrible efficiency for the numerous animals that inhabited the valleys and plains of that region. This was in the Pleistocene Period, during the Glacial Epoch, when much of the northern part of the continent was buried under great fields of ice. Southern California, far below the southern limits of glaciation, had probably a less arid climate than now, and a very large and varied animal population, mostly of extinct species, and some of them very widely different from the living animals of the region.

Excavations for road asphalt in this formation were commenced in 1874 by Major Hancock, the owner of the ranch. The material was melted down, to free it from impurities, and shipped in barrels to San Francisco and elsewhere. The work was not continued, as the cost of purifying the product was too high for it to find a profitable market at that time. It served to call attention to the fact that the asphalt contained numerous bones or fragments of bones, and when examined by scientists it appeared that these were not modern bones, but belonged to extinct animals. Prospecting for fossils soon showed that around the little oil springs, or where springs had formerly come up, there were pipes or chimneys of soft asphalt, which were veritable ossuaries, packed full of the bones of these extinct animals, mostly in marvelous preservation. The excavations of the local scientific societies, and the more extensive work carried on by the University of California, have yielded many hundreds of skulls and tens of thousands of skeleton bones, of a great variety of animals large and small. The bones are impregnated with asphalt, otherwise little altered; but flesh and hide, horns and hoofs have completely disappeared, dissolved out by the petroleum and long since converted into bitumen, water and gases. The skeletons are never articulated; the bones are all jumbled up together in a crowded mass by the slow internal movements of the half-liquid asphalt in which they were entombed thousands of years ago.

It is safe to say that the La Brea asphalt is the richest repository of fossils ever discovered, if we consider the variety of extinct animals found in it, the perfect preservation of their remains and the ease with which they can be extracted and cleaned up. It is practically unique: asphalt deposits of this type are common enough wherever an asphalt base petroleum comes or has formerly come to the surface, but bones have rarely been found in them and never upon any such scale as this.

How many kinds of animals are represented in the collection is not yet known. Over fifty species of birds have been identified, and there are probably at least as many kinds of mammals. The most remarkable fact is the great abundance of carnivorous quadrupeds and birds of prey. Wolves, lions and saber-tooth tigers, eagles and vultures are the most common of all the remains found; next to them stand the larger herbivora, bisons, horses, ground sloths and larger ruminants and wading birds; while remains of smaller quadrupeds and perching or ground birds are comparatively rare. This is a fact of grim significance, for it indicates that the larger quadrupeds, venturing out upon the seemingly solid surface, and caught in the asphalt, served as a bait for animals and birds of prey, luring them from all the country round about and enticing them within the treacherous clutch of the trap. These in their turn, falling victims, served to attract others of their kind. And so the "death-trap of the ages," as a poetically-minded Californian writer called it, self-baiting, automatically disposing of its prey, has collected and preserved to our time a truly wonderful series of the predacious animals and birds. The smaller animals, light and active, and seldom venturing beyond the brink of the pool, were not often caught.

In February of last year (1913) the writer paid a visit to this locality at a time when excavations were in progress for the University of California. The object was to study the conditions at the "tar-pits" as a guide to the construction of a characteristic group exhibit for the American Museum, and to secure by exchange with the Californian museums a full representation of the fossil fauna. Every possible courtesy was received from the several institutions mentioned in getting together the necessary data and materials, and especially from Prof. J. C. Merriam of the University of California. The group as it stands is based chiefly upon the studies and



**The Asphalt Group in the American Museum of Natural History.**

The new group shows the saber-tooth tiger to the left, extinct wolf to the right and ground sloths in the foreground.

* Reproduced from the American Museum *Journal*.

conclusions of Prof. Merriam, so far as we have succeeded in understanding and expressing them correctly. In effect, it is meant to convey a picture of the operation of this Pleistocene death-trap. No attempt is made to cover the skeletons with flesh and hide—this the visitor may imagine for himself; and add if he pleases the scanty vegetation of a dry country around the margins of the asphalt spring.

Two ground sloths (*Mylodon*), great heavy, thick-haired, clumsy, clawed beasts distantly related to the living tree sloths, but as big as a grizzly bear, have been caught in the asphalt. In spite of their struggles indicated in the disturbed and broken surface of the pool, they have sunk down until only the head and fore limb of one, and the head of the other, appear above the black asphalt.

A saber-tooth tiger (*Smilodon*) one of the most powerful and dangerous of the extinct beasts of prey, has been attracted by the struggles of the hapless ground sloths, and hastened to the spot to kill and devour them. But in his eagerness, he too has been trapped and is now vainly trying to extricate his feet, already beginning to sink below the surface of the dark, treacherous pool.

Meanwhile, a fourth animal, the great extinct wolf (*Canis dirus*) has come up. More wary, or as yet more fortunate, he has come over the solid hardened asphalt, and avoided the treacherous surface of the pool. He sees his ancient and dreaded enemy the saber-tooth and the powerful and bulky ground sloths in difficulties where neither teeth nor claws will avail against his attack. He dare not yet spring in to attack them, but leaps about on the margin of the pool in high excitement, barking out his real opinions in regard to saber-tooth tigers, which under ordinary circumstances he would reserve to a safer margin of distance. The *Smilodon*, distracted for a moment from his desperate attempts to free his feet from the entangling mass, answers with a savage snarl, which we may interpret as a wish, soon to be fulfilled, that the wolf would bear him company in his troubles.

Such is the little drama that our group sets forth. A realistic story it is—a characteristic incident which must have happened, pretty much as we have told it, again and again during the time—many thousands of years ago—when these tar-springs were active.

That thousands upon thousands of animals, great and small, perished by this frightful death in the tar-pits of La Brea, is witnessed by their skeletons; that so large a proportion of them were savage beasts of prey may be to some a consolation, although nature accords no higher place or superior morality to the vegetarian over the carnivore. At all events, it does not appear that the trap was seen by human eyes in the days of its vigor. No remains of man, tools, weapons, or other indications of his presence have been found associated with the extinct animals. There are various reasons for the belief that man is rather a recent arrival in the New World, and had not reached the Pacific Coast when these animals were perishing in such numbers in the tar-pits. Still he might have witnessed it.

The fossil skeletons used in preparing this group were presented in exchange by the University of California, through Prof. J. C. Merriam, to whom we are also indebted for most of the evidence upon which their grouping is based, and many helpful suggestions and criticisms.

# Kapok

## A Buoyant Stuffing Which Makes a Mattress Into a Life-raft

We think of travel by water as unsafe. Possibly statisticians can prove that it is safer than travel by land, and we may be sure that it is safer than travel by air, but even so, it is unsafe. It always has been unsafe; even in our modern times, with the experience of centuries to guide us, we dread the peril of the sea.

Nor need we fear the mighty ocean only; the rivers and lakes take their toll, and it is as great as the sea's. We hear less of it, or, at any rate, we pay less attention to the reported fatalities on our inland waters; a "Titanic" or a "Volturno" disaster occupies the front pages for several days and impresses us greatly, but so would a collection of minor fatalities if presented properly. And, anyhow, those immediately concerned are as grievously affected by the small scale mishap as by the tremendous "Titanic" catastrophe.

So that anything new looking toward making sea travel safer will benefit all of us who travel by water, whether on the ocean itself or on inland waters, whether in great palatial ocean liners or in the little motor boat or rowboat. If it is good, we want it; we are beginning to take heed of the new slogan, "Safety First."

There is a vegetable fiber called Kapok which ought to be better known than it is, for it is such a valuable agent in helping to make water travel safe. It has been valued for its buoyant properties for some little time, but not being well known, its worth has not been generally appreciated. It is a wonderfully buoyant material, and is of value and interest to all water travelers, whether big ship sailors or little boat sailors.

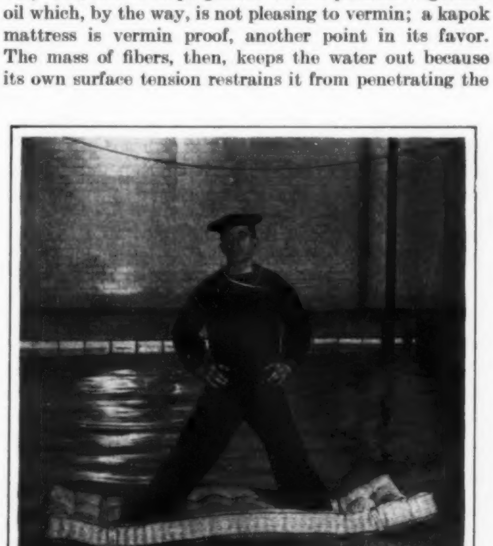
Kapok is a fibrous, silky material which grows in the seed pods of a tropical tree. This tree grows in the East Indies, India, West Indies and other tropical lands, but it is only that which comes from the island of Java that has this remarkable property of buoyancy to a satisfactory and reliable degree. None other than this Java kapok need be considered in this connection, and not all the Java kapok is as good as some of it.

These seed pods are three or four inches long, and about one inch in diameter in the middle; the seeds and kapok fill it just as cotton and the cotton seed fill the cotton boll. But the seeds are large, about the size of peas, and the kapok is very silky and fine, so that when the pod is broken the seeds are readily removed, and the kapok can be baled; it is very compactly baled, to reduce bulk, and then shipped by sea; the United States imports a considerable quantity of it even now.

It is a very fine, silky fiber, of very short staple, but it has none of the tiny little hooks or tendrils found on cotton, wool and silk, and so it cannot be spun or woven. It is, however, a remarkable material for filling mattresses and cushions, and for that use it comes into the market. Other kapoks than the Java kapok can be used for this purpose, but they are not buoyant, and are not quite so resilient, and so they are not so valuable.

After receipt in this country it is put through a process which thoroughly cleans it, restores its resilience and brings out its fluffiness. It is then ready for use as cushion or mattress filling. It is the material known as "silk floss," except that ordinarily mattresses are stuffed with a kapok other than Java kapok, and these "silk flosses" may even be adulterated with cotton; moreover, it is frequently used without putting it through the special process mentioned above, so that it is not thoroughly cleaned and it may be somewhat lumpy. So, plainly, the purchaser of kapok-stuffed mattresses and cushions should know something about kapok.

The prime Java kapok, it has already been said, has wonderful buoyant properties. The fiber is very, very fine, and is impregnated with a peculiar vegetable oil which, by the way, is not pleasing to vermin; a kapok mattress is vermin proof, another point in its favor. The mass of fibers, then, keeps the water out because its own surface tension restrains it from penetrating the interstices of the mass. Java kapok will support in water *twenty times its own weight;* and if the kapok is in a leather or artificial leather casing it will continuously support this weight for *two months* or more before the water does finally penetrate the mass sufficiently to make it sink.



**This view shows what a very effective life-raft the Kapok mattress makes.**

The Navy Department, in purchasing Java kapok, puts a representative sample through a rigid test. One pound of kapok is stuffed into an artificial leather pillow 12 inches square and 4 inches thick; it has one tuft in the center. To this is attached 19 pounds 6 ounces of lead and the whole is placed in water. Lead is specified because a weight of lower specific gravity would weigh less in water than lead. The cushion must support this weight for 48 hours without sinking.

Then the resiliency is tested. The real Java kapok puffs right up in the sun; a wet mattress laid out in the hot sun will come up to its original condition. So this wet cushion is exposed to the sun for 4 hours, whereupon it is compressed to 3 inches thickness, held at that for 24 hours and then put back in the sun and air. It must come back to its original thickness in 48 hours. If the kapok goes through these tests successfully and is as clean and well processed as the standard, then it is considered to be good kapok.

Suppose that every ocean liner was equipped with mattresses stuffed with this kind of kapok; suppose, for example, that the "Titanic" had been so equipped, how much less the loss of life would have been. The photographs show how an ordinary kapok mattress will support a man. A mattress containing 10 pounds of kapok will support a 200-pound man lying on it. As a man in the water weighs only about 5 pounds owing to his own partial buoyancy, the mattress will keep afloat 40 men hanging to it. In other words, one of these mattresses will keep afloat all the people that can get hold of it.

A motor boat cushion may be 4 feet long, 18 inches wide and 4 inches thick; it will contain about 6 pounds of kapok and serve as a life preserver for all who can hold to it. And instead of being stowed away in a locker or under a thwart, where it cannot be reached, it is on a bench or thwart and is the handiest thing in the boat to throw overboard.

An artificial leather cushion excludes water better than a mattress covered with ordinary ticking; yet a mattress, in a test, easily supported 6 men, and then was loaded with 200 pounds of cast iron which it supported for 8 hours. The "Titanic" survivors were picked up in much less than eight hours.

It might be thought that there would be a fire risk incidental to the use of this material. It is so light and fluffy that in a room where it is being worked—where cushions are being stuffed, for example—it burns with startling rapidity. Yet in mass it does not burn; the air cannot get at it. A pinch of kapok held between the thumb and forefinger burns like gun powder; a ball of it simply smoulders and will not burst into flame even when poked. To investigate the danger to the ship, if a smoker of the Mark Twain school let his lighted cigar or cigarette fall on the mattress, the experiment was tried; the cigarette made the ticking char and then the kapok began to smoulder. But it would not flame up, even when poked, and finally after 15 or 20 minutes waiting a pitcherful of water quenched the fire. There is no danger whatsoever from this cause.

The Navy is beginning to use this material; the merchant marine will not be interested until kapok cushions and mattresses are acceptable, in lieu of cork life preservers and life-rafts, to the steamboat inspectors. Perhaps when people learn how to buy kapok and know what they are getting, it will come into use in the merchant ships. Its use will increase the safety of sea travel very greatly.

Kapok-stuffed cushions can be bought in the stores—some stores. If purchase can be made subject to satisfactory behavior during the test described above, the purchaser is safe in feeling satisfied, though it is well to know, in addition, that the manufacturer is a reputable maker of such goods.

# Antarctic Problems*

## The Problem of the Antarctic Andes and the Antarctic Horst

By Prof. Edgeworth David, C.M.G., F.R.S.

As the Weddell Sea will be the objective this year of no fewer than three Antarctic expeditions, some of its features as bearing on the above problem may be discussed first.

The continuity of Coat's Land, discovered by Dr. W. S. Bruce in the "Scotia" in 1904, with Prince Regent Luitpold Land, discovered by Dr. Filchner in the "Deutschland" in 1912, has still to be traced. Filchner sighted three Nunataks of dark rock rising from the inland ice to the south of "Vahsel Bucht," thereby proving indisputably the existence of land under the inland ice. The inland ice there rose gently from its shore cliff of from 25 feet to 65 feet high, up to more than 3,000 feet at a distance from the shore of about thirty miles. Of far greater importance is the tracing inland of the unknown coast to the south of Luitpold Land.

This is one of the greatest of the geographical problems which the Shackleton Expedition should solve. Amundsen, on his journey to the south pole in 1911, proved that the south-easterly trend of the Queen Alexandra Range, discovered by Shackleton at the Beardmore Glacier, is not maintained in the Queen Maud Ranges, but that the latter ranges bend to the right as one follows a great circle from the Beardmore Glacier to Graham Land. So far, this favors the theory of Penck that Antarctica is divided into a West and East Antarctica respectively, by a strait connecting the Ross Sea with the Weddell Sea, for the trend of the Queen Maud Ranges, if continued farther north in the western hemisphere, would carry it to Luitpold Land.

There can be little doubt that this Queen Maud Range is bounded by heavy fractures, of the order of several thousands of feet, for geological reasons which will be stated presently; and that these trend lines are, perhaps, as strongly pronounced as are any in the world. If, therefore, the ranges, to which they give origin, extend toward Luitpold Land, they are certain to be strongly marked, and should be capable of accurate delineation by the Trans-Antarctic party of the new expedition. If, on the other hand, as seems more probable, the Queen Maud Ranges, when traced into the Weddell Quadrant, bend back towards Graham Land, and become continuous with Charcot Land and King Oscar II. Land, then Shackleton's other party, operating from his main base at the head of Weddell Sea, should be able to solve this all-important problem. With its length already proved of no fewer than 1,400 miles, and its height of from 8,000 to 15,000 feet, its stupendous fracture lines, involving displacements of 5,000 to 6,000 feet, and its profound influence on the meteorological conditions of Antarctica, and probably of the southern hemisphere, it is not the least important of the mountain ranges of the world, and certainly yields to none in its geological interest and the extreme difficulty of the problems which it presents.

At the Graham Land end of Antarctica, Arctowski, Nordenskjold, Gunnar Andersson, Charcot, and Gourdon have proved that petrographically and tectonically the rocks are distinctly Andean. Granodiorites, and Andesitic rocks, in which zoned soda-lime felspars are characteristic, are there predominant. Boulders of gneissic rocks present in Tertiary strata at Seymour Island suggest a pre-Cambrian foundation complex at no great distance. Recently Dr. W. T. Gordon has identified well-preserved Archæocyathinæ in a large block of limestone dredged up by Dr. W. S. Bruce in the "Scotia," from latitude 62 deg. 10 min. South., longitude 41 deg. 20 min. West, from a depth of 1,775 fathoms, near the South Orkney Islands, and specimens of *Pleurograptus ceratiocaris* and *discinocaris*, previously described by Pirie, from the collections by Bruce in the South Orkneys, prove the existence there of Ordovician rocks. The sedimentary rocks are largely formed of Jurassic plant-bearing strata, with one of the richest known fossil floras of that age in the southern hemisphere. In the west and central parts of Graham Land these have been strongly folded, and mostly overfolded to the east, as has been the case with the greater part of the formations developed in the South American Andes. Farther east in James Ross Island, Snow Hill, and Seymour Islands, etc., there is a gently inclined series of marine Cretaceous rocks, followed by Middle Tertiary rocks (Upper Oligocene to Older Miocene) with fossil leaves of Fagus, Araucaria, etc., a geological structure recalling that of East Patagonia and southern Argentina, as compared with the folded highlands of West Patagonia and southern Chile.

*Summary, published in *Nature*, of a paper read before the Royal Geographical Society on February 9th by Prof. Edgeworth David, C.M.G., F.R.S.

Then the zone of active or dormant volcanoes, which intermittently characterizes the Andean Chain, is met with on both sides of Graham Land, in Bridgman, Paulet, and Deception Islands, on the west, and in Lindenberg, Christensen, Sarsee, and the Seal Island volcanoes on the east side. If now a comparison of the broad structural features of West Antarctica be made with those of East Antarctica in the Ross region, it will be noticed that a great volcanic zone stretches along the western shore of Ross Sea from at least so far south as Mounts Erebus, Morning, and Discovery, to so far north as Cape Adare. This main volcanic zone of the Ross Sea region is crossed by lesser zones trending more or less east and west, like the Mounts Terror, Terra Nova, Erebus, and Dry Valley zone, the zone of the Balleny Islands, etc. If, however, this Ross Sea volcanic zone with the adjacent mountains be compared with the ranges and volcanic zones of West Antarctica, the fact at once becomes obvious that the ranges of the Ross area are entirely devoid of folding, and are of a block-faulted plateau type, whereas the lavas and tuffs of the Ross region are very distinct from those of West Antarctica, being strongly alkaline, of the nature of trachytes, phonolites, kenytes, etc., and of as distinctly Atlantic type as the West Antarctic rocks are of Pacific type.

The problem is further complicated by the fact that, meagre as it is, our knowledge of the geology of the King Edward Land area shows the eruptive rocks there, in which granodiorites are conspicuous, to be more nearly allied to Andean rocks than are those of Ross Sea. There, too, in the Ross Sea region, a vast coalfield with nearly horizontal strata sheets over all the older rocks from near the south pole itself to near Dr. Mawson's base in Adelie Land, a distance of more than 1,600 miles. According to the preliminary report published in "Scott's Last Expedition," vol. ii., Mr. F. Debenham considers these Coal Measures to be of Upper Palæozoic age. Like the Coal Measures of Santa Catharina in southern Brazil and the northern Argentine, lying far to the east of the Andean fold area, they are but very little disturbed. Moreover, the structure of the mountains to the west of Ross Sea resembles in some respects that of the Falkland Islands, which again lie a little to the north-east of the Andean fold lines.

In the Falkland Islands undulating Devonian sandstones and quartzites lie with strong unconformity on a pre-Cambrian (?) crystalline complex, and are themselves succeeded by a nearly conformable group of Permo-Carboniferous strata with a well-marked glacial bed at its base which links it up at once with the Orleans glacial conglomerate of the Santa Catharina Coal Measure system. In his recent paper to this society, Mr. T. Griffith Taylor mentioned that the fossil fish-scales recently discovered by Mr. F. Debenham and himself at Granite Harbor, were considered by Dr. A. Smith Woodward to be of Devonian age, and the fossil tracks figured respectively by H. T. Ferrar from the lower Beacon Sandstone of East Antarctica, and by Nordenskjold from the Devonian rocks of the Falkland Islands, show such a remarkable similarity to one another as to suggest that they are both of Devonian age. Now these late Palæozoic Coal Measures and Devonian rocks, more or less horizontally stratified, are far more characteristic of the outer foreland of the Andes, that is, the vast lower plateau or plain country lying to the east of the Andes, than they are of the Andes themselves. Sections are exhibited across typical portions of the Andes and their foreland massifs, together with type sections showing the probable geological structure of West as compared with East Antarctica, and a comparison is made between the structure of the Antarctic Horst with the "ice divide" on the lower plateau to the west, and that of the main divide between southern Chile and southern Patagonia, as described by H. Steffen, F. P. Moreno, and others. It is suggested very tentatively that in the Andean problem of the Antarctic, a new physiographic enigma is propounded, viz.: When does a mountain range lose its identity as a definite unit, and become another range worthy of a different name?

The South American Andes are characterized and defined by both folds and faults. In West Antarctica, the folds are present with the thrust directed easterly as in the Andes; the volcanic zone is present, and fractures are also present, as well as typical Andean eruptive rocks. In the Ross Sea region in the mountains along its western shore, the great fracture lines are perhaps continuous with those of Graham Land, but the Andean folding has died out, as well as the petrographical Andean province which is found rather in King Edward Land than in the mountains to the west of Ross Sea.

Provisionally it is suggested that while Arctowski's term, the "Antarctandes," may be used for the mountains of West Antarctica, some such term as the "Antarctic Horst" may be applied to the great ranges of the Victoria Quadrant. The party to be dispatched by Shackleton from his Weddell base westward for 400 or 500 miles, which should include someone who is both an experienced geologist and physiographer, should be able to throw a flood of light on this great Andean problem.

Then, too, a great opportunity is offered by this expedition for sending a strong party from the Ross Sea base, not only to lay out depots so far as to the head of the Beardmore Glacier to meet the Trans-Antarctic party on their arrival from over the great inland plateau, but also to collect systematically from the highly interesting Coal Measures, at the head of the Beardmore, with their associated fossil flora. The Shackleton expedition found wood, apparently allied to, if not identical with, coniferous wood, at the head of the Beardmore Glacier, and fossil rootlets in the adjacent shales suggest that the wood grew near where it is now found; and Captain Scott's party have brought back specimens of fossil plants scientifically of the utmost value from the same locality. There, too, at Buckley Island, or Nunatak, thick beds of Cambrian limestone with traces of Archæocyathinæ underlie the Coal Measures. It is difficult to imagine any spot in the world more fascinating from the point of view of geology, palæontology, and many allied sciences.

The problem of how trees, like modern forest trees, could flourish within 300 geographical miles of the south pole itself, which now for five months of the year is in almost total darkness, is one which involves the question as to whether the south pole was in late Palæozoic time in its present position, or whether, if the position of the earth's axes of rotation have remained constant throughout geological time, the continents may not have crept horizontally over considerable distances, as suggested by Sir John Murray and G. W. Lamplugh. The presence of the rich Jurassic flora at Hope Bay in Graham Land and of the Miocene flora of Beech and Araucaria at Seymour Island presents a similar problem.

*Coast Survey.*—The existence or not of New South Greenland, originally reported by Morell, is of importance for study by the various expeditions which should be in that vicinity this year and next year. Soundings, currents, and meteorological conditions suggest that New South Greenland really exists.

The recent fine piece of coastal survey work by Dr. Mawson and his Captain, J. K. Davis, whereby about 1,300 miles of new coast have been added to the map, greatly needs to be extended, so as to join up with Lieut. Pennell's latest surveys to the east, on the Scott expedition, and also to connect westward with Kemp Enderby Land and Coat's Land. Obviously the Andean problem cannot be finally settled until the great unknown area between Charcot Land, King Edward VII. Land, and Carmen Land is thoroughly explored and charted.

*Meteorology.*—R. C. Mossman has shown that Antarctica is of vast importance in controlling weather, not only in its own immediate neighborhood, but even so far north as the subtropics of Chile. This very important result from the establishment of Dr. Bruce's Meteorological Station at the South Orkneys, and the later system of meteorological stations in the far south, instituted and maintained continuously by the enterprise and insight of the Argentine Government, is likely to be confirmed in the case also of East Antarctica. Just as ice conditions in the Weddell Sea largely control the rainfall of subtropical Chile, so it is probable that ice conditions in the Ross Sea may control some portions of Australasian rainfall. Unquestionably very important results have been obtained from the establishment of Dr. Mawson's wireless meteorological station at Macquarie Island in the sub-Antarctic. The Federal Government is so much impressed with the importance of the results that it has decided to maintain this station for a time, experimentally, at its own cost.

In the coming expeditions, it will be important to get meteorological data as to the location of the chief cold pole of Antarctica, and as to whether the low-pressure area of Ross Sea ever leads to air being sucked over from the Weddell Sea region, or *vice versa*. Both are low-pressure areas, so that, when their seas are ice-free, air obviously would stream into them normally from the high polar plateau. The trend of the dominant Saatrugi should be systematically mapped *en route* by all sledging expeditions. Measurements of the upper-air currents to supplement the work of G. C. Simpson, so admirably carried out on the Scott expedition, are much to be desired, as well as studies of evaporation and ablation

generally in regard to precipitation. A meteorological observatory at the head of Weddell Sea should greatly enhance the value of the Argentine southern observatories.

*Glaciology.*—These problems are also interesting and important. The Weddell Barrier, as shown by the soundings, has, like the Ross Barrier, recently retreated at least 100 miles south of the position which it once occupied in late geological time.

It will be important to ascertain whether in the Weddell Sea, as at Gaussberg, at Adelie Land, at Termination Land, as well as in the Ross Barrier region, the ice has everywhere been recently retreating. The importance of the evidence of moss ice ("respirator ice") in the lids of crevasses, as indicating sea-water underlying barrier ice, should not be overlooked. The position of the Main Ice Divide on the south polar plateau should be carefully determined, as well as the directions and rate of movement of the inland ice and of the outlet glaciers. The origin and history of the outlet valleys—among the deepest in the world—which transect the Antarctic Horst, offers a most fascinating problem. Shafts of moderate depth should be sunk in the far inland snowfields to determine the crystallinity of the material.

*Biological, physical,* including magnetic, observations, as well as *chemical,* and particularly *oceanographical* investigations should, of course, not be neglected. In regard to oceanography, it may be suggested that not only should a general survey be made to develop the continental shelves, submarine ridges, and banks and deeper basins, but detailed surveys should be made in the neighborhood of large floating piedmonts, so as to determine the existence or not of ice-scooped rock-hollows where such glaciers reach the sea floor, and of something like a terminal moraine where the barriers ended when at their maximum extension. Careful sets of serial temperatures should be taken at close vertical intervals in the sea around such floating glacier piedmonts and barriers at various seasons of the year. These should throw much light on the amount of annual loss, through melting at their base, that such floating barriers must undergo.

## Food Production and Population*

### Theories That the Latter Increases More Than the Former Declared Fallacious by the United States Government

Nearly every theory that has been advanced in recent years, to the effect that population in this country is increasing faster than the food supply, is hit hard in a report just made by the Committee on Statistics and Standards of the Chamber of Commerce of the United States of America. This committee attempts to show that the theories mentioned are based on erroneous figures of the statistics for the decade 1899–1909. The fear of less food for more people is declared to be merely the old Malthusian doctrine which, according to the committee, "sought to show that the food supply of the world increases only in arithmetical progression, while population grows in geometric progression, so that hunger, self-denial, and poverty are the inevitable portion of the greater part of the human race. This proposition is entirely unanswerable on paper, but is principally remarkable for not being so, since it is contrary to all human experience."

The statistics relied on for the popular belief referred to show that, in the decade of 1899 to 1909, population in this country increased 21 per cent, while the yield of cereals in 1909 was only 1.7 per cent greater than in 1899. On the face of things, this looks bad, but it is said to be misleading so far as the comparison is concerned.

THE WRONG PERCENTAGES.

When it comes to population, the percentage of increase is actually shown. The comparison as to cereal production, however, is taken from two years at each end of the decade, when the real comparison should have been the average of the entire ten years. "Everyone familiar with agricultural statistics," says the committee, "knows that the difference in production between a good year and a bad year is sometimes very startling. It happens that the year 1909 was a poor year for corn, showing a decrease of 114,000,000 bushels as compared with 1899, while all other cereal yields in 1909 showed increases over 1899 all the way from 3 per cent to 142 per cent, but as corn was much the largest factor it pulled down the whole proposition to only a small net increase."

Other grains during the period increased as follows: Buckwheat, 32 per cent; rye, 15 per cent; edible beans, 122 per cent, and rice, 142 per cent, the latter amounting to 6,000,000 bushels. During the same period, Kaffir corn and Milo maize increased from 5,000,000 bushels to 17,500,000 bushels, or approximately 240 per cent, and since then there has been a further great increase in these two cereals, and a very extensive planting of feterita and similar sorghum grains in the West and Southwest. These grains, while principally used as stock food, are being more and more used as food for human beings since they are nearly as nutritious as Indian corn.

"To show the fallacy of the reasoning in comparing any two special years as a means of arriving at a definite conclusion as to a tendency," adds the committee, "let us compare the yields of some staple crops in 1912 with those of 1899 to demonstrate how easily the reverse statement can be proved:"

| | 1899 Bushels. | 1912 Bushels. | Per Cent Increase. |
|---|---|---|---|
| Corn.......... | 2,666,824,370 | 3,169,137,000 | 18¾ |
| Wheat........ | 658,534,252 | 730,267,000 | 18 |
| Oats.......... | 943,389,375 | 1,418,337,000 | 53 |
| Rye........... | 25,568,625 | 35,664,000 | 39 |

Attention is called to the fact that between 1899 and 1909, oatmeal grew steadily in use as human food, "and, consequently, had greater food value than formerly, proportionately much beyond its increase in production." Other factors entered, such as the enormously increased production in vegetables, fruits and nuts. "Irish and sweet potatoes," says the committee, "divide with bread the claim to being the staff of life, for they are especially the poor man's food. In the decade in question, Irish potatoes increased 42 per cent, and sweet potatoes 39 per cent, while in 1912, the production of Irish potatoes broke all former records."

* New York *Times.*

PRODUCTION OF VEGETABLES.

It is difficult to get any reliable statistics in regard to the production of vegetables. The Census Bureau says its figures are probably much underestimated. What facts are available show an increase in 1909 over 1899 of 27.8 per cent in acreage devoted to vegetables, and the value of the latter, exclusive of Irish and sweet potatoes, grew from $120,000,000 in 1899 to $216,000,000 in 1909. Beyond these data, observation shows the remarkable growth of the truck industry in many parts of the country. Texas shows this, especially. A few years ago saw the beginning there of the Bermuda onion industry, which has grown to about $3,000,000 per year. Similar growth is shown in the truck farms around Norfolk, Va., the eastern part of North Carolina, the vicinity of Charleston, S. C.; Southern Georgia, a large portion of Florida, Southern Alabama, much of Arkansas, Southern California, and Southern Colorado, besides many other places.

When it comes to fruits, a condition somewhat similar to the cereals is shown. Thus, orchard fruits as a whole show a gain of 1.8 per cent in the decade, but this was due largely to the decreased production in 1909, as compared with 1899, of apples which form the largest item of all orchard fruits. As the committee remarks: "It is one of the physical peculiarities of apple trees that they never produce two large crops in succession; so that any one year selected for the purpose of comparison is apt to lead to wrong conclusions. As a matter of fact, so far as statistics are available, the apple crop of 1912 shows an increase of 15 per cent over that of 1899, while that of 1909 was about 20 per cent less than the latter."

In the decade, peaches showed a gain of 129 per cent, pears 33 per cent, and grapes 97 per cent. Oranges and lemons showed 216 per cent increase and grapefruit 3,700 per cent. Melons, cantaloupes, etc., showed equally large increases. In nuts, peanuts showed an increase of 62 per cent, or 7,000,000 bushels, and other nuts increased from 40,000,000 pounds to 62,000,000 pounds, or approximately 55 per cent. Olives increased 220 per cent.

FOOD OTHER THAN CEREAL.

On these things the committee makes this comment: "The enormous output of vegetables and fruit has brought down the price, which in turn stimulates the demand, and the cry of great cities is for cheap and wholesome vegetables in season and out. All of these things are human food, supplementing, and often supplanting, other kinds of food, and are, therefore, of vast importance in the study of the future of the food supply. The only available comparison in production of fruits, vegetables, and nuts, with that of cereals, is one of money value, and, while this is not conclusive, it at least forms a good basis of comparison. The value of all cereal crops in 1909 was 48.6 per cent of the value of all crops, while that of vegetables, nuts, and fruits was 11.6 per cent, which is a very much larger proportion than is generally known."

The committee also combats the notion that grain exports have shown a steadily decreasing ratio in percentage to size of crops. All that can be said is, it claims, that the ratio of exports of wheat, which is the principal grain export, compared with the total crop, varies from year to year, according to many conditions, the principal one being the size of the crop in this country.

Another "fallacy" attacked by the committee is that "the land is being impoverished by constant and unintelligent cultivation, and that its productive power is, therefore, decreasing from year to year." It is claimed that Government statistics show a steady but slow improvement in the right direction, and that "innumerable Federal and State experiment stations and intelligent farmers all over the country have demonstrated clearly the ability of scientific and intensive farming to produce crops at a greater rate of increase than any probable increase in population."

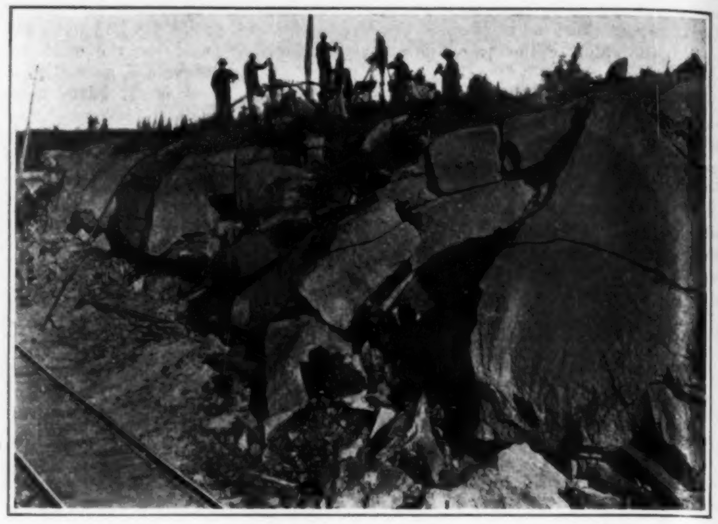
The committee's conclusion is: "If, therefore, we survey the field in sober thought rather than the Cassandra-like spirit of prophecy, the outlook seems to be for a greater variety, increasing abundance and a more reasonable price of food for the people." The Chairman of the committee is A. W. Douglas of St. Louis. Other members are: A. Ross Hill, of Columbia, Mo.; C. J. McPherson, of Frankfort, Ind.; Dan Norman, of Chicago; and Bryon W. Holt and N. I. Stone of this city.

## The Fire-Damp Whistle-Indicator

Prof. F. Haber, the chief of the new Kaiser Wilhelm Institut für Technische Chemie, recently lectured in that institute on the acoustic fire-damp indicator which he had devised in conjunction with Dr. Leiser. The principle adopted is not altogether new, if we are not mistaken. But most of the fire-damp indicators in use are, of course, of the Davy safety-lamp type, the flame of which shows a blue cap and becomes very hot when the air contains fire-damp. In the new indicator two tubes, or pipes, are used of the same effective length; filled with the same gas they would give the same note, but if the one gas is lighter than the other, there will be beats when the two pipes are blown simultaneously, and the number of beats will increase with the percentage of the lighter gas. The one pipe is charged above ground with air; the other is charged below ground with the mine air. Methane has a little more than half the density of air. The two whistles are sounded simultaneously by a very simple device, which is practically an air-pump. As the explorer advances into the air under suspicion, he sounds his whistle, and the more contaminated the air is, the shriller the sound will become. The apparatus consists of a metallic cylinder, 250 millimeters in length and 60 millimeters in diameter, all encased; the lower portion is fitted with a cylindrical cap, which can be pulled down a certain distance. That is all the man has to do, and the operation is thus very simple; the construction is, however, by no means so simple. Inside the cylinder is an air-pipe system and a mine-air—we will say gas, simply—pipe system. The air enters near the upper end, is taken down a pipe and up again, impinging upon a plate of mica; this plate limits the effective pipe length. The air is then taken down again and rises once more, and escapes finally through a long coiled pipe, which takes up about half the length of the cylinder. This coil serves for storing the air, with which this system is filled above ground, in the pipe, without mixing with the mine air while the apparatus is being carried down below. Up till the moment when the whistle is to be used the air-inlet is kept closed by a screw. The gas-pipe system is generally similar to the one described, but differs in several essential respects. The gas entering through another inlet pases through a filter and through a column of soda lime—to remove dirt and carbon dioxide; it then flows up to the mica plate, from which it is taken through a long pipe into a special receptacle within the cylinder. This receptacle can be enlarged in the manner indicated by pulling the cylindrical cap down; when this is done a piston moves down in its barrel and draws gas into the pipe system; when the cap is pushed home again the next moment, the gas is forced out through another tube and a valve (which regulates the pressure); the gas then enters the mouth-pieces of the two pipes, and these pipes are blown. In reality the cap need not be pushed home; the vacuum created in the barrel forces the piston back again as soon as the man lets go. Further particulars will be found in the journal *Naturwissenschaften* of October, 1913, and in Beyling's article in *Gluck Auf* of December 13th. According to experiments made in the experimental gallery at Derne, and in the Gneisenau colliery, the note can be heard at a distance of 100 meters, and the instrument has given satisfaction. The whistle cannot cause an explosion in fire-damp, but it will not replace the safety-lamp. It means an additional apparatus which cannot be combined with the lamp, and which is not automatic. The latter is the chief defect; on the other hand, the whistle is useful in penetrating into dangerous air in which the safety-lamp might go out and could not be re-lighted.—*Engineering.*

Apple wood is the favorite material for ordinary saw handles, and some goes into so-called brier pipes.

Close view of the last section of rock to be blasted.



Rubble quarry for the cofferdam. Present main line in background.

# The Rainy Lake Fill

## An Episode in the Building of a Three-Thousand Mile Railroad

By Rex Croasdell

THE Canadian Northern Railway had its beginning in 1896, when "Dan" Mann and "Bill" Mackenzie—the one a lumber jack, contractor and railway man, the other a country school teacher, contractor and embryo financial genius—took hold of a hundred miles of line in Manitoba that began nowhere and ended at much the same place.

For seventeen years the Canadian Northern has averaged a mile of new line a day. "Dan" Mann and "Bill" Mackenzie are Sir Donald and Sir William now, and the Canadian Northern early this season will drive the golden spike that marks the completion of its transcontinental line from the Atlantic to the Pacific Ocean. The story of its building is a story of tremendous pluck and pertinacity, combined with foresight and faith unwavering; but it is not the purpose of this article to describe that. We have to deal with only one of the unending engineering problems that necessarily must arise in the construction of over 3,000 miles of railway—in short, with the Rainy Lake fill.

Rainy Lake is a beautiful sheet of water, lying on the borderland between Ontario and Minnesota, a silver shield among a host of tiny mirrors, a fisherman's paradise in a land of countless lakes and streams. To the west and a little north lies Winnipeg, where the West's wheat comes from; to the east and a grain south lies Port Arthur, at whose wharves the great freighters lie waiting their turn under the spouts of the elevators. To carry its share of the wheat the Canadian Northern in 1901 started construction on a line between these two important points, and the rapidly growing western provinces clamored for the rapid completion of this new outlet to the lake navigation.

Through this lake-dotted region the engineers found many difficulties. They skirted the south shore of the Lake of the Woods, bridged streams, threaded their way past small lakes and hacked their right-of-way through primeval forests. In seeking a route for the line, the company decided to tap the iron deposits of Atikokan and Mattawin in the hope that a rapid development would follow the steel. That development is taking place to-day. But to do this, the company put the engineers up against the hardest problem of all—the crossing of an arm of Rainy Lake and the construction of a permanent and solid right-of-way over nearly three miles of water, varying in depth from a few inches to sixty feet, and broken up by half a dozen small, rocky, pine-clad islets.

Temporarily, they solved the problem with the construction of trestles, but trestles are merely a sop thrown to the great god of Speed, and the problem was merely postponed, not solved. In 1910, with the Transcontinental rapidly taking shape, the company made a survey to locate a permanent crossing.

At first a series of steel bridges were contemplated. This did not work out. The engineering difficulties were too great, and so was the cost. The great depth to rock bottom forbade concrete pier foundation. The mud overlying the rock was too soft to hold clusters of piling, and yet was too stiff to permit rock-filled cribs being sunk to solid bottom for footings. The only possible solution was the placing of a heavy fill to force a way to the rock. Soundings were taken through the ice for two winters, and were finished on open water during the spring of 1910, as many as 28 soundings being taken in a day. The route was laid out and work commenced. Soundings were taken with rods driven down to the rock, and the location determined in a manner similar to that used where hills and valleys have to be contended with. Estimates were compiled, showing the number of tons of rock required to be dumped into the waters of Rainy Lake in order to reach a firm foundation of solid rock under the mud and the lily-pad roots. Incidentally, these estimates were later completely vindicated. From the mainland to Island No. 1, thence to the next and the next little rocky lump of land until five had been passed and the opposite mainland reached. It was announced that the company would construct a double-tracked permanent way of rugged granite construction across the three miles of water and rock, and early in the summer of 1910 the contracts were let and preparations for the task begun.

By July station men were starting short fills out from the shores of some of the islets. On September 16th the first big "shot" was fired. In October digging with steam shovels was inaugurated. That winter two shovels were kept at work, and in the following summer four were in commission. Until the fall of 1912 these four shovels attended by eight standard-gage locomotives, two "dinky" engines and sixty dump cars forwarded a steady stream of rock to the dump. The biggest output in one month was 50,000 cubic yards of rock. The record for one steam shovel in one day was 155 cars, or about 900 cubic yards. Some single rocks loaded by these 95-ton Model C Bucyrus shovels weighed more than 20 tons. The shovels load a car with broken rock in five minutes.

When the dumping began, the real difficulty of the enterprise became apparent. How to accomplish successfully the apparently impossible feat of dumping rock in the water ahead of the fill faced the engineers. The man who finally submitted the adopted plan established a precedent in engineering. The unique dumping apparatus he devised was really a floating bridge, consisting of two plate girders 6 feet high and 140 feet long. These were placed 30 feet apart, and supported a pair of tracks, as on an ordinary bridge. The forward, or water, end was floated by a barge 34 feet wide and 112 feet long; the embankment end rests on the permanent way when the dumping is in progress and is upheld by a crosswise truss between two small barges, one on each side of the grade, when floating is effected to a new position ahead. The rock-trains are run out upon this floorless bridge and their contents hurtle down to the lake bottom. About one third of the grade is added afterward by side dumping as the bridge is moved on. This barge permitted the dumping of a train of six cars at one time.

On May 1st, 1911, dumping commenced on the second channel filling, 3,000 feet across. Forty train loads of rock per day during one entire year were dropped into Rainy Lake before this filling was completed. Repeatedly the dumping was continued within a single car length for two weeks before one rail could be laid on the foundation thus provided and the track extended ahead. Sometimes sudden settlings occurred during the working hours, and train and crew had to run for their lives.

Electric power, a voltage of 6,600, was brought from Fort Frances, a distance of 7 miles, to operate the drills. Two motors of 200 horse-power each ran two compound air-compressors which supplied 1,046 cubic feet of air per minute compressed to 100 pounds per square inch, at which pressure pipes carried this air to the drills. These put down holes in diameter from 2 to 3 inches as far as 28 feet. Following the drillers come the powder men, who spring the holes repeatedly with dynamite until a pocket large enough to contain the explosive necessary for a giant blast is made. The largest of these giant shots contained 56,000 pounds of dynamite and broke up 50,000 cubic yards of rock. There were about 350 holes 26 to 28 feet in depth and 12 to 13 feet apart, some opposite and some alternate. In general, the holes were spaced about one half their depth, and about 100 holes fired at once by electric current. Of this class there were, up to last fall, about 75 fired, averaging from 10 to 15,000 cubic yards. This rock is an extremely hard, fine-grained, gray gneissoid, a granite deposited under pressure. The total rock filling will aggregate nearly 1,000,000 cubic yards measure, solid, in original position, and the average haul is one mile.

When the new line was finished from the east end as far as Island No. 1, a temporary connection was made to put in service this part of the permanent way, with only one of the old temporary bridges, the cutting through Island No. 1 being widened to permit a seven-degree curve between old and new tangents crossing there; and also a shoo-fly trestle was constructed south of the uncompleted east bridge, employing an eight-degree curve in an opposite direction to the one on the island.

An attempt was made in filling the last hundred feet of the embankment east of the bridge abutment to dump rock around piling driven on this line of the shoo-fly, the idea being to drive these pilings to rock bottom before building the embankment, since it would probably be impossible to get them through this filled rock slope later. The deck was removed and the trestle readjusted three times, but despite the effort to back fill against it, the head of the embankment, which must progress forward with a dredge of rock advancing on top a large quantity of mud, pressed forward, pushing everything ahead of it. When this fill finally reached the gap there were no more pilings for bents, so after the dump was widened and filled to grade on center line, bents were framed on rock filling on the line of the shoo-fly. Part of the balance of the trestle was framed on a cofferdam crib.

Another thing that had to be taken into consideration in the construction of this three-mile double-track rockway is the fact that Rainy Lake is navigable, and the passage of steamers and logs consigned to the mills at Fort Frances had to be considered. To meet the latter exigency the company decided to throw two lift bridges of modern type across two of the waterways. These, however, present no more than the usual problems in the construction of such a bridge, and need not be described in detail.

The last stretch of fill west of Island No. 1 is to the mainland, and as the gap became too short to use the great dumping barge in the regular way, it was necessary

Preliminary work for the bridge.

A busy scene. Note the string of dump cars on the right.

to dismantle it. The dump was forced to settle as much as possible by filling the pockets, and, after allowing a few days to elapse, filling again repeatedly until the embankment would hold up. Then the steel work was moved ahead and the forward end of the girders blocked up on the fill built out from the far shore a year before and the big barge withdrawn. Then the rest of the gap was filled by dumping direct from the steel work. When the fill was solid across the entire gap, this was taken apart.

The Rainy Lake fill is now comparatively close to completion, and the wheat crop of 1914 will be routed over this solid double-track permanent way *en route* to Port Arthur. It is only one of the many difficult engineering feats entailed by the construction of the railway, two other notable ones being the three-and-one-quarter mile tunnel driven through the heart of Mount Royal to enable the Transcontinental to reach its terminals in the heart of the city of Montreal, and the four-mile tunnel at Vancouver, on the opposite side of the continent.

## Let the Swing of Your Door Wind Your Clock

A French inventor, Gustave Delannoy, has hit on the idea of putting the constant opening and shutting of doors to a useful application. He proposes to keep his clock wound by this agency. The apparatus employed for this purpose, as described in *La Nature*, is quite simple. A glance at our illustration will enable the reader readily to follow the details. A pump is hinged to the framework of the door at *a b*, in such manner that on opening the door the piston, whose outer end is pivoted to the leaf of the door at *c*, is pulled out and draws in a charge of air. This is subsequently expelled, on closing the door, and passes out through a tube *h* to the clock. A somewhat modified

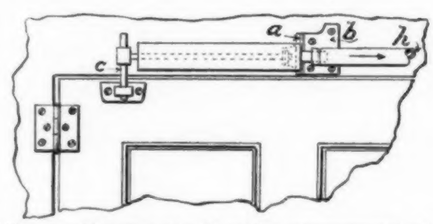



Fig. 1.—Diagram showing the arrangement of cylinder and piston over the lintel.

arrangement, which explains itself, is shown in Fig. 1. It need only be explained that *f* is a weight attached to the bottom of the cylinder, causing it to descend when the door is closed.

The accompanying photographs show the works of a pendulum clock and of a clock run by springs, both wound by the Delannoy method.

When necessary, a number of pumps or bellows can; of course, be used to compress the air for various clocks, their number and dimensions, of course, depending on the power required and the number of mechanisms to be wound up. The pump has a rubber connection joining it to a metallic tube, the inner section of which may vary between 1/10 to ¼ inch in diameter, and the length of which may exceed 300 feet. This tube is fastened along the wall, and ends either in a receiving bellows placed behind the clock to be wound (this bellows expanding by the compressed air), or is connected with a cylinder containing a piston run by the same power. The bellows or the cylinder wind up the weight, or spring, of the clock, or may operate directly on the works of the clock itself. A safety valve is provided to prevent an excess of pressure from accumulating. This safety valve is actuated by the weight of the clock in such manner as to prevent over-winding. In spring-operated clocks, a ball valve fulfills a similar function.

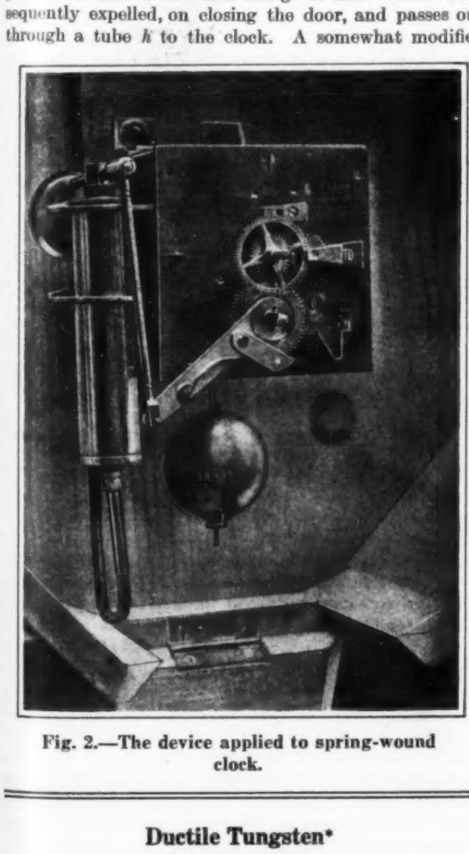


Fig. 2.—The device applied to spring-wound clock.

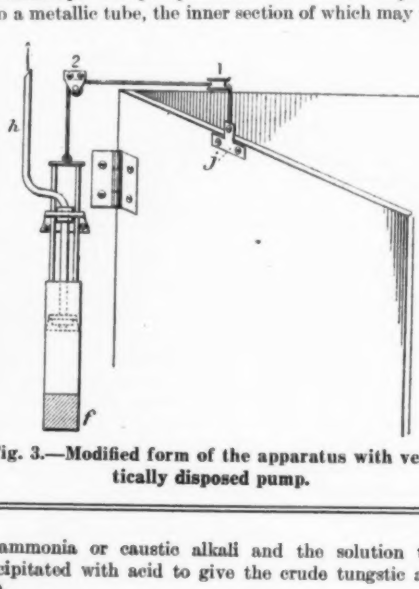



Fig. 3.—Modified form of the apparatus with vertically disposed pump.

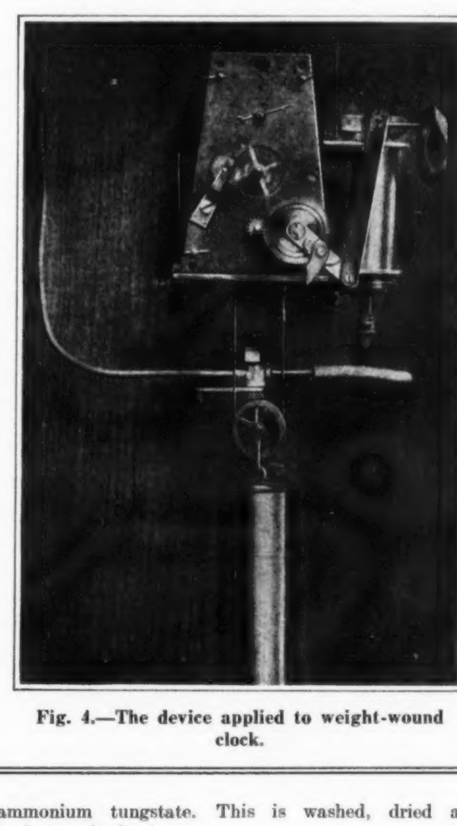


Fig. 4.—The device applied to weight-wound clock.

## Ductile Tungsten*

By R. W. Moore

Probably no other element has had such a rapid rise from comparative obscurity to great industrial importance as tungsten since the development of a process of rendering this hitherto extremely brittle metal ductile. Tungsten is by no means a rare element. The two chief minerals are scheelite (tungstate of calcium) and wolframite (tungstate of iron and manganese).

Scheelite is readily broken up with hydrochloric acid, forming calcium chloride, and leaving the tungstic acid mixed with the various insoluble portions of the ore (mostly silica). The tungstic acid may be dissolved in ammonia or caustic alkali and the solution then precipitated with acid to give the crude tungstic acid, $WO_3$.

Wolframite is most readily broken up by fusion with an alkali flux (caustic soda or carbonate) extracting the alkali tungstate with water and precipitating the tungstic acid as before. This crude oxide, roughly reduced with carbon, is the product used by the steel industry and is the metal that sells for approximately a dollar a pound.

But for the metal that is to be used for making ductile tungsten, this oxide contains too much impurity. The impurities vary with the ore, but the main ones are Fe, Mn, $SiO_2$, Ca, Mo, P, As and Na salts. Two methods of purification are in general use:

First, solution in ammonia and crystallization of para ammonium tungstate. This is washed, dried and broken up by heat.

Second, solution in ammonia and precipitation of tungstic acid with hydrochloric acid.

A third method which is used where still greater purity is desired is a combination of the other two; i. e., crystallization and then the decomposition of the crystals with aqua regia.

The first method removes a large portion of all the impurities, but gives a heavy dense oxide from which it is more difficult to get a metal of satisfactory qualities.

The second method gives an oxide purer from some impurities than the crystallization method, but does not remove the P and As at all completely; these, however, come out later in the process of working the metal. This oxide is light and readily reduced.

*Abstract of a paper read before the American Chemical Society and published in *Metallurgical and Chemical Engineering*.

Two methods of reduction are being used, one with carbon and the other with hydrogen. By far the greater proportion of the metal used is hydrogen-reduced. Reduction by carbon is much less readily controlled, since under certain conditions the carbon may burn either to $CO$ or $CO_2$; also some of the lower oxides of tungsten are volatile at fairly low temperatures. The finished metal must contain practically no carbon and practically no oxygen; also the density of the metal must not vary much from a certain standard, and it must not be crystalline. To realize all these conditions is somewhat difficult, but this method is in successful use.

The reduction with hydrogen is more readily controlled and is the process generally used. The oxide is reduced in electric resistance furnaces, with the temperature and rate of hydrogen-flow under careful control. The furnaces used are of two different types: First, porcelain tubes wound with platinum ribbon embedded in an insulating material either alumina or silica; and second, furnaces of the Winne and Dantsizen type, employing alundum tubes wound with tungsten or molybdenum wire, embedded in insulating material, contained in tight casings through which hydrogen is flowing to prevent oxidation of the winding. Each type of furnace has its advantages.

The oxide is loaded into the furnaces, either in boats, or directly into the tubes, purified and dried hydrogen passed through, and the temperature brought gradually up to about 1,000 degrees to 1,100 degrees. The rate of heating and the rate of hydrogen-flow largely determine the quality of the metal. This reduction process gives a completely reduced metal without any crystalline structure; the density of the metal is under control and variable at will within the limits.

The tungsten thus produced is a dull-gray amorphous powder. The process of working this powder into a tough, ductile metal is radically different from any in use with other metals (except Mo).

Tungsten melts at about 3,200 deg. Cent. Even in spite of its extremely high melting-point, it is possible to form melted globules of tungsten of considerable size by means of a vacuum arc furnace. But tungsten that has been melted is extremely brittle and a globule of it when struck with a hammer flies into pieces like glass. It is impossible to work pieces of tungsten which have been melted. Hence other methods of getting the tungsten into wire-form had to be worked out.

In the early days of the tungsten lamp the tungsten powder was always mixed with some binder, either organic, like starch and the various gums, or metallic, such as some of the amalgams. The mixture was then squirted under pressure through dies, and the binder subsequently removed. Wire made by these methods was unsatisfactory, being extremely brittle and fragile.

Since the process of making *drawn* tungsten wire was developed, practically all wire and other forms of ductile tungsten are made by the following process:

The dry tungsten powder, without binder of any form, is placed in a very heavy mold, care being taken that the powder is evenly distributed in the mold. The metal is then pressed into a bar by heavy pressure in a hydraulic press. This pressed rod has very little strength. It is carefully pushed from the surface of the mold into a slab of some material (usually molybdenum) and then placed in a furnace, usually of the Winne and Dantsizen type, heated to about 1,300 degrees. A current of hydrogen is passed through the tube to prevent oxidation. The bar is heated for about half an hour and then pushed out into a water-cooled extension of the furnace. This heating has sintered the metal so that the bar has sufficient strength to be readily handled without fear of breakage.

This bar is now clamped between two heavy water-cooled clamps, and a water-cooled cover or treating-bottle, as it is called, is lowered over the whole. A current of dry hydrogen is passed through the bottle, and the bar then heated gradually up to a dazzling white heat, in fact, nearly to its melting-point, by passing current through it. After a few minutes at this temperature the current is gradually turned off (to prevent air sucking back into the bottle and causing an explosion) and the bar allowed to cool. The tungsten is now thoroughly sintered and the bar is very strong, but as yet it has no ductility whatever.

From this point on the treatment of the bar varies slightly according to the use to which the metal is to be put. Sometimes the metal is rolled, sometimes swaged. The process in general is this: The bar is placed in an electric resistance furnace through which hydrogen is flowing and heated to about 1,500 deg. Cent. (till it smokes in the air). It is then grasped with tongs and inserted rapidly into a swaging machine and then quickly withdrawn. It is reheated, and the other end passed into the machine. Care must be taken that the rod is passed rapidly into and out of the machine, so that it is not cooled too much.

The size of the dies is gradually decreased; several dies are used in bringing the rod from a square to a circular form. As the rod becomes smaller the steps between the dies gradually become smaller and smaller, the temperature is gradually decreased, and when the rod is long enough it is fed through the machine mechanically by rolls, being drawn through a gas furnace or gas flame to heat it. When the diameter has been reduced to about 30 mils the wire becomes ductile at ordinary temperature.

From this size down to the smallest diameter the wire is drawn through diamond dies, first quite hot (600 degrees to 650 degrees) with a gradually decreasing temperature as the wire becomes smaller. The steps between the dies are gradually decreased from 1 mil at 30 mils to one twentieth of a mil at 14 mils and below. Wire as fine as one half mil has been successfully drawn.

When not desired in the form of a wire the treated bars are often rolled instead of swaged; sometimes both processes are combined. The metal is rolled hot in a manner similar to that used in swaging. From the rolled bars and sheets various articles are made, such as contacts for electric apparatus of various kinds, X-ray targets, etc.

Tungsten is too hard to work on a lathe or to be machined with tools. Hence other methods have to be used to get tungsten into any desired form. The metal sheets or bars are heated very hot and then the desired pieces sheared, punched or forged out.

The properties of wrought or ductile tungsten are interesting. It is pliable, strong and tough. It is practically non-oxidized in damp air, and it resists acids to an unusual degree. It is unattacked by HF, only slightly attacked by $HCl$, $HNO_3$ or $H_2SO_4$ of any concentration hot or cold, or by aqua regia. Alkali solutions do not attack the metal, but fused alkalis dissolve it slowly. A mixture of $HNO_3$ and HF dissolves the metal rapidly. The specific gravity of tungsten is about 19.3. Its tensile strength is exceedingly high; samples of one thousandth of an inch diameter have been obtained with a tensile strength of 600,000 to 650,000 pounds per square inch (several times that of steel).

The most important use for tungsten is, of course, as a filament for incandescent lamps. It is also being extensively used as a contact material where an electric circuit has to be made and broken repeatedly in the air, as in magnetos, etc., on automobiles and in voltage regulators. Considerable use is being made of tungsten as a target in X-ray tubes, where it is being found exceedingly valuable. Tubes of tungsten are made and used as the heating unit in a furnace, in which a temperature of 2,500 degrees to 2,700 degrees can be obtained in about five minutes, starting at room temperature. The furnace can be cooled and opened in about ten minutes, hence such a furnace is of the highest value in experimental work at high temperatures. The furnace can be filled with hydrogen or used as a vacuum furnace as desired.

A further use of tungsten is as a heater-winding for resistance furnaces such as the Winne and Dantsizen type and others. The temperature at which these furnaces can be run is limited only by the temperature which the tube or support on which it is wound will stand.

# Some Sources of Leakage in the Engineering Industry*

## Importance of Efficient Tool Equipment, Layout of Plant, Adaptability of Design, and Amount of Stock

By A. A. Peebles

It is impossible in the scope of a brief survey of the subject to treat adequately all the different sources of leakage which may arise in the running of an engineering plant. Each individual case which is examined has its own leakages, some of which may be peculiar to itself, and due to an inherent fault of original planning or to a defect in the management or discipline of the organization. Yet there are some phases of the question under consideration so common, but so seldom emphasized, that a brief summary of the various leakages most frequently met with may not be out of place.

For the purposes of this article leakage may be defined as all unproductive expenditure of time or effort on the part of either the men or the machinery employed in an industrial undertaking, and may also embrace the unprofitable expenditure of capital. It is, moreover, one of the most prevalent and insidious diseases which attack efficiency—prevalent because there are so very few of even the most modern plants into which leakage in one form or another does not creep; insidious because those who suffer from it so rarely know of its presence. To become aware of a source of leakage is frequently to overcome that leakage. It is the loss which is unnoticed that eats into efficiency and consumes dividends.

There are not a few engineers—owners or managers of engineering plants of one kind or another—who blame competition for the loss of business and the decrease in profits which their organizations experience. To a certain extent this may be the cause, but only to a certain extent. If a business loses contracts because other firms underbid its quotations, or if it can secure contracts only by quoting prices which permit of no profit, it is a sure sign that other firms can do the work more cheaply. They are out for profit also, and under normal conditions will not quote prices that do not yield a fair return. Any firm which cannot compete with such prices is operating inefficiently. In other words, the aggregate of its leakages is high, for efficiency is merely the absence of leakage.

It is, perhaps, no exaggeration to say that of the total money expended in the engineering workshops of the world, one fourth is wasted on unproductive effort of one kind or another, and that of this fourth at least a half is conservable. Such items as loss of time and power and the wear and tear of machinery involved in the return stroke of slotting, planing and shaping machines are examples of wastage which cannot well be eliminated at the present stage of machine tool development, although the day is not far distant, to judge from present indications, when even such losses as these will be avoidable. It is our aim, however, to deal here only with such of the more common leakages as are at the present moment wholly or partially remediable.

### UNSUITABLE AND POOR EQUIPMENT.

One of the most prevalent sources of leakage in the engineering works is poor equipment. Too much stress cannot be placed upon the importance of up-to-date machine tool equipment. Any efficiency expert in the engineering field will endorse the statement that old or unsuitable tools are responsible for more inefficiency than is any other cause. Factory managers and owners seem to be reluctant to invest in a new plant while the old can, by any means, be made to suffice. When a machine is worn out they will scrap it, but very few will scrap a comparatively new tool merely to make room for a more efficient one. Yet, in deciding when to throw out an existing machine to make room for a new one, the question of the condition of the former should not be the determining factor. The question should be looked on purely as one of business. The operating cost of the existing machine should be computed, and also the operating cost of the proposed new one. The output of each should be carefully estimated, and the final decision based purely upon the results thus obtained. If the installation of the new tool is going to return a reasonable interest on the capital invested, the new tool should be put in. In estimating operating expenses, such items as a percentage of rental and rates proportional to the floor space occupied by the tool, and also a percentage of the interest on the capital invested in the building and of the depreciation thereof, should be considered in addition to such items as interest on capital invested in the tool itself, depreciation, operator's wages and power used.

The only occasion upon which there is room to question the advisability of installing a more efficient machine tool in place of one of smaller capacity is when the demands of the plant are such that they can be conveniently coped with by the existing machine. In such a case the only saving effected by a change is in the operator's time, the overhead charges of interest, depreciation and floor space, rental being the same in each case. Such instances are, however, rare, and in most cases the progressive policy of scrapping out-of-date equipment for that of a more modern nature will be found to pay.

The writer recalls one instance which illustrates the effects of wholesale scrapping. In the north of England there is a small general engineering and millwrighting shop which, until a few years ago, was still operating an equipment composed of old, slow-speed tools. It was a busy shop, and in order to do all the work considerable overtime was necessary. It never paid. Work had to be taken at prices that would not permit of the extra cost of overtime in addition to the high cost of

* Reproduced from *Machinery*.

production due to inefficient equipment of the plant.

A change of management, however, put things on an entirely different basis. The new man raised money and put in a practically new equipment consisting of powerful high-speed tools. He also installed a new power plant with electrical distribution and speeded things up all around. The result was that the capacity of the plant was augmented to such an extent that its output was materially increased without the necessity of any overtime, and the cost of production was so reduced that the firm was able to quote lower prices than formerly and realize a useful profit in the bargain.

Instances parallel to the foregoing could be multiplied at will. There are many shops operating at a low efficiency simply because the management is reluctant to throw out machines until they are worn out. It is comparatively rare to find an instance where the reverse is the case. That such a contingency is possible, however, will be illustrated by another experience. In this case the shop (also a small one) specialized in valves and steam fittings. Among other machinery was a battery of three hollow spindle capstan lathes which were employed in turning out spindles for a patent valve from the bar. These machines were quite capable of meeting current requirements and were rarely required to do overtime work. It happened, however, that while visiting a machinery exhibition the manager saw some new machines of the same type, but of a more powerful and improved design, and was so impressed by them that he ordered three and had them put in place of the old ones. The approximate net cost of the change was $3,500. The saving effected was the money previously paid in overtime, which rarely exceeded $10 a month, and was usually less. This represents a saving of considerably less than 3½ per cent—a poor investment from a business point of view. Yet against this it must not be forgotten that the maximum output of the plant had been increased against possible future demands.

INEFFICIENT POWER GENERATION.

Apart from the machine tool equipment of an engineering works considerable loss may arise from inefficient power generation and distribution. It has been estimated that the average cost of power in the different industries amounts to only five per cent of the total cost of production, and for this reason it is sometimes regarded as immaterial. Yet in these days of keen competition, even the smallest source of leakage is of importance, and in the progressive shop obsolete and inefficient power arrangements are no more to be tolerated than obsolete machine tools. The writer knows of two cases which show what can be done in the way of improving power facilities. Both are extreme, perhaps, and consist in replacing a plant of exceedingly wasteful nature by the most efficient available. In one instance the saving in power paid the whole cost of the work of installing the new plant in three years. In the other all the machinery of the factory was driven and the building lighted with electricity for a cost approximately equal to that of lighting the place with town gas, as had been done previously.

The layout of a plant is a very important factor in the equation of efficiency. This should be carried out on lines calculated to reduce the amount of handling to a minimum. Repeated and unnecessary handling of material during the process of manufacture is a potent cause of costly production and one which is very frequently found. Material should be made to pass, in so far as possible, through the different departments in order. The disposition of traveling cranes is an important consideration, as is also the method in which the different classes of machines are grouped according to their purposes and in relation to the other parts of the plant.

Where an engineering works has been originally laid out along lines which are not the best, it may not always be advisable to go to the heavy expense of entirely remodeling the whole plant. Yet much can be done in many directions to reduce the unnecessary handling, if a little thought be given to the matter, without undue expense. An example of this is afforded by a large Tyneside shipyard in the "old country." Two cupolas were operated in connection with the foundry and were kept constantly busy. At one time these cupolas were fed by means of hydraulic lifts. Fuel and pig iron were loaded from the cars on a neighboring siding onto the lifts and were then fed to the cupola—two handlings only being required, but when the quantity of material is considered, the second handling constitutes an item of some importance. By building a trestle incline from grade level to that of the charging platform, and running the cars up directly to the latter, the second handling was obviated at a relatively small expense. The direct saving effected in laborers' wages was considerable, and, in addition to this, the time saved in charging increased the efficiency of the whole foundry.

Up-to-date equipment in the way of machine tool fixtures and accessories, special tools, jigs and small tools, is scarcely less important than the efficiency of the tools themselves. A good tool-room foreman and staff are among the most valuable assets of the modern engineering works. To have a complete and well kept stock of tools and accessories stored in such a way that any particular one can be found at the shortest notice is to increase the efficiency of the whole plant. Good storekeeping is also an important factor and the reverse a prolific source of small leakage. When men have to wait several minutes while the storekeeper is looking for a certain tool or some stock material, there may be a considerable waste of time, particularly when such waiting is a general thing. It is important that material, both in the tool and stock stores, should be so disposed that anything asked for can be produced without delay.

ACCUMULATION OF SCRAP.

There is another source of leakage which, though usually small, is found in a large number of engineering establishments and is rarely reckoned with. The accumulation of scrap is a source of small leakage in nine out of every ten shops, and it is one which is most easily overcome. Scrap in a shop or in a yard takes up valuable space; it is in the way and is generally a nuisance. It also represents so much capital lying absolutely idle. It has a cash value, and its value, if realized, might be used to advantage. In the majority of engineering works far too much scrap is allowed to accumulate before it is disposed of or put to useful purposes in the cupola. The writer was once called on to make a valuation of the entire plant of one of the largest shipbuilding concerns in the north of England. The estimated weight of the scrap which littered the yards and the different departments was 1,000 tons, much of which had obviously been lying around for years. Cast iron, steel and wrought iron were all piled together, with a considerable proportion of brass and gun metal in the form of bearing bushes, stuffing-boxes and the cylinders of old feed pumps. Our estimated value of the whole of the scrap was $21,000, which sum, invested at the rate of 5 per cent, would give an annual income of $1,050. A small item, perhaps, in view of the size of the plant, but one which counted. It was a dead and unnecessary loss, and in addition to this, the scrap was in the way and was occupying valuable space.

The leakages previously dealt with have been those most commonly met with in the operation of the work's department of an engineering firm. There are others which have their origin in the offices, and which are not without their importance in the matter of efficiency. Among the chief of these is the matter of adaptability in the designing department. Let us consider a firm that manufactures steam fittings on a large scale as an example. In such a firm it will often be found that every valve or other fitting is designed with no regard for existing types, or for types undergoing contemporaneous design. The result is that for every type of valve or other fitting an entirely new set of details has to be made. By a little adaptability in design it would be possible very often to utilize, in new designs, existing patterns for the main castings and existing types of spindles, seating and other details. The saving effected in manufacture would be considerable if in the new design the same patterns used in an existing design could be employed. This principle applies with more or less force in many other lines of manufacture. The secret of the success of the manufacturers of the Ford automobile has been duplication—the making of all their engines alike. This has rendered possible the production of an efficient car at a price unheard of previously.

There is still one other point to touch on in connection with the executive end of the engineering business, before this cursory review of the matter of leakage is brought to a conclusion. That is concerning the matter of stock. From the engineer's point of view stock can be divided into raw material and finished product, and a careful adjustment of both these divisions is essential to efficiency. In buying raw material, under which head may be included pig and bar iron, and often studs, bolts and other material not produced in the works, the markets must be carefully watched and purchases made in so far as is possible when the market is favorable. Sufficient stock must be carried in all lines to avoid the possibility of running short unexpectedly, with its attendant holding up of work and waste of time; on the other hand, too much stock should not be purchased. Stock in the shop is capital idle, and it takes up space, which is also true of finished stock. A sufficient quantity should be kept on hand to meet possible demands, and to guard against loss of business on account of inability to give early delivery, but an excess of stock above this quantity is inadvisable. It represents an unprofitable investment of capital, and there is the risk that some of it may become out-of-date before it is disposed of. This adjustment of stock, both in regard to raw material and finished product, is one which demands nice judgment. In quiet times manufacturers not infrequently continue to run their plants at or near capacity, with the result that a surplus stock is accumulated which is difficult to dispose of. Stock should be kept within reasonable limits even if it means a shut down for a time. It is the best policy in the end.

## Western Industries in China

The unsettled condition of affairs in China has delayed the progress of Western industries, but it is evident that as soon as the opportunity offers there will be great developments, as there are in the air a large number of paper schemes for manufactures of all kinds. The province of Hunan is, as usual, to the fore in company promoting, and the industrial projects recently discussed there include paper factories, cotton-spinning and cloth-weaving mills, flour-milling and rice-hulling establishments, a cement factory, a timber-sawing factory, a cigarette factory and a glass factory, besides such further enterprises as leather-boot making, hat-making, dyeing, printing, silk-reeling and the manufacture of sugar and felt. The lack of native capital and the opposition to foreign capital have, however, in the meantime, prevented many of the proposals being proceeded with, and the list of factories actually opened in 1912 is a small one. Among others actually opened are a boot-making factory, a glass-making establishment, a cotton mill and a flour mill. The manufacture of leather seems to be receiving special attention, a leather factory having been established at Chungking and a Franco-Chinese tannery at Tientsin. Probably, for some time, the more important works will be carried out by the municipalities, as they can raise the necessary capital more easily than private individuals. A new and powerful electric light plant was erected in 1912 in the French extra concession at Tientsin. Electric light was installed at Yrumanfu, and there are electric light projects at various stages of advancement in a dozen other cities. It was decided two or three years ago to have a system of electric tramways in Pekin, and foreign financial assistance has been promised from many quarters; but the terms of the concession are apparently such as to preclude the use of foreign capital, and no progress has been made. Canton has also a big tramway scheme under consideration, not to mention projects for hydraulic power, new roads and other city improvements. Very few cities in China have waterworks or drainage systems, although these are much more necessary than electric light; the difficulties of finance seem to be at present insuperable. As regards the development of the resources of the country, the Commercial Attaché to H.B.M. Legation at Pekin says the Chinese argument is: foreign supervision and control leads to loss of independence; foreign capital cannot be obtained except under conditions of supervision and control; therefore none but Chinese capital can be employed. But the result of the use of Chinese capital with Chinese methods is that Chinese capital is no longer forthcoming, and the argument becomes what the old logicians called a "vicious circle." The fallacy lies in the failure to differentiate between the necessary degrees of supervision and control. In the case of railway construction and in certain other exceptional enterprises a solution has already been found, and it may be expected that experience will teach young China that in all industrial undertakings a certain modified degree of foreign control is for the present necessary. There are few, if any, Western industries which could not be successfully carried on in China, as the resources of the country are so large and so varied; and when these are even only very partially developed, China will be a very important factor in the industrial world.—*Engineering.*

## Neon Tubes and the Aurora Borealis

The origin of the Aurora Borealis still remains mysterious; nevertheless, a very ingenious explanation has just been given to the Academy of Sciences by M. George Claude in a paper presented by Prof. d'Arsonval. M. Claude has noticed that the difference of potential at the limits of neon tubes decreases to a half, third, or quarter of the ordinary value when the diameter of the tube doubles, triples, and quadruples, so that very small voltages would suffice to work enormous tubes. Besides the practical consequences of such a state of things from a lighting point of view, this observation, as Prof. d'Arsonval suggests, brings with it the explanation of one of the most interesting physical problems of the globe. If, indeed, the results of M. Claude are applicable to other gases of the globe, the magnificent Aurora Borealis, which are but the electrical discharges of nebulous action, would only require differences of potential far inferior to what might be thought necessary and the existence of which was difficult to understand.—*Chemical News.*

# The Light That Fails

## A Plea for an Eight to Four Working Day

By A. A. Murdoch

The failure referred to is not the fault of the light. The fault is ours that it fails. The light is there, but we are asleep with the shades down. Every day, during the greater part of every year of our lives, we keep on doing the same thing, sleeping through the life-giving sunshine instead of getting up and getting the full benefit of its exhilarating influence. We have become so accustomed to our habits of life that we do not see how ridiculous we are when we hang on to a schedule of living that leaves us no time after business is done for recreation and exercise in the open air. Radical changes are always difficult to accomplish, but any scheme that will give us an extra hour's sparetime-sunshine every day of our lives should be worth trying even if it upset our entire *modus vivendi* to do it.

Four years ago all England was stirred up over a "daylight saving" scheme by which one hour's more sunshine was to be transferred from morning to evening for a period of five months from the middle of April to the middle of September. The plan was to put the hands of the clock forward one hour at midnight on the 15th of April and on the 15th of September to set them back again as they were. By this simple and childlike expedient of changing the nominal time one hour ahead, people would without knowing it get up an hour earlier in the morning and find themselves with an hour's more daylight to spare between the time they finished work and the time they went to bed. The man whose schedule was:

| | | | |
|---|---|---|---|
| Rise at | 7 | would find himself during the five months referred to really observing the following sun-time schedule: | 6 Rise |
| Begin work | 9 | | 8 Work |
| Quit work | 5 | | 4 Quit |
| Go to bed | 11 | | 10 Bed |

And of course during his recreation hours before going to bed he would find an hour's darkness replaced by an hour's daylight—the hour 4 to 5 replacing the hour 10 to 11—thus enabling him to put in a full hour's more exercise in the open air each day, which is exactly what nine men out of ten want more than anything else in the world.

The main objections to that plan were and are three:

1. That twice a year the transportation schedules of the entire country would have to be adjusted for the hour eliminated.

2. That it would confuse our arrangements with other countries.

3. That it would throw mid-day over to 1 o'clock and conflict with astronomical and navigators' time.

Although the scheme got to the stage of a Parliamentary bill, it died a lingering death in committee, and has not since been resuscitated. There was, however, an almost universal consensus of opinion that the idea was a good one, although it does not seem to have occurred to the British that there was any other way to gain the desired extra hour's sunshine than the above-described roundabout way of flim-flamming themselves by changing the clock. Instead of setting their clocks an hour ahead and trying to delude themselves that they were thereafter getting up at 7 o'clock as usual, when in reality it was only 6 o'clock according to sun time, why should it not have occurred to them that the same thing could be accomplished by simply getting up at 6 o'clock—real sun time 6 o'clock—and changing their schedules of rising, eating, working, playing and sleeping accordingly?

Why tinker with the clock? Noon and midnight are our starting points, our zero's; noon, when the sun is highest, and midnight, when the sun is farthest behind us; and it would never do to change those to one hour after noon and one hour after midnight, to upset our scientific friends, the astronomers and the navigators, and put us out of gear with the rest of the world.

There is no need for fooling ourselves by any such childish and unscientific expedient. All we have to do is to arrange beforehand to advance by one hour the transportation, rising, eating, working and sleeping schedules of the entire country on a given date, and when that day comes just get up an hour earlier in the morning and the whole sequence of life would flow along one hour ahead without deception as to the actual time of day.

Take the case of a man who rises at 7 in the morning and goes to work at 9. He is the man who needs exercise most and gets least. Let us see what the change would do for him. Make the working day 8 to 4 instead of 9 to 5. Then everything else would follow suit. Meal times would adjust themselves and transportation companies would have to make the necessary changes to adapt their schedules to the new rush times and quiet times. Factories, stores, shops, offices, exchanges, schools, churches, theaters, etc., would be compelled to fall in line, and almost without knowing it he would be living a new life with an hour's more sunshine added to his spare time. The light that fails, the hour wasted on us while we unconsciously slumber in bed with the shades down, would be snatched from oblivion, with the result that when our day's work is done we would have an extra hour to spare for the enjoyment of our favorite amusements or the riding of our pet hobbies.

A glance at the accompanying chart will help to convince the unbelieving that we are really in the habit of sleeping altogether too late in the morning, the startling fact being clearly revealed that those who rise at 7 in the morning all the year round waste on an average a trifle over one hour's direct sunshine in bed that could be transferred with advantage to their spare time in the evening, a total loss of over 365 hours or more that 30 twelve-hour days in a year. It sounds like a month's vacation.

On the chart the period of total darkness is shown in black and the dawn and twilight are shaded, leaving the daylight portion white, except for the section 8 o'clock to 4 o'clock, which is dotted to indicate our new worktime. By following the line "Sunrise" it is easy to see that by getting up in the morning at 6 instead of 7 we would gain a block of sunlight running all the way from February to November that would otherwise have been wasted in bed; and that by going to work at 8 instead of 9 and quitting at 4 instead of 5 we are increasing our spare daylight time by one whole hour per day. By changing the working hours to 8 till 4 we place the working zone right in the middle of the day, four hours before noon and four hours after noon, thus getting in exact line with ship's time, which might be specially advantageous in work connected with shipping and docks. Another advantage would be that all exchanges and markets would open one hour earlier, giving them an extra hour's business with London, at least until similar measures are adopted in England.

The chart shows the exact amount of direct sunlight available to us in New York throughout the year, varying from $9\frac{1}{4}$ hours (7:30 to 4:45) in December, to a little over 15 hours (4:30 to 7:35) in June. Even during the darkest time of the year, therefore, on an 8 to 4 working day basis, we would have light both going to and returning from business, a most desirable achievement, and quite an improvement on the old basis of 9 to 5, which would necessitate going home after sunset. There is no need, therefore, to make the change a temporary one during the summer months only. This would necessitate two changes a year and would lead to endless confusion. If it is decided to try the experiment, let it be continued right along during the entire year, beginning about June 1st. On that particular day the sun rises about 4:30 and sets about 7:30, and presuming that we rise at 6 we would have two whole hours of direct sunlight to do what we like with before we started work and $3\frac{1}{2}$ more after we quit at 4 o'clock, and our sparetime-sunlight would go on increasing slightly from that day till June 21st. From then it would steadily decrease until December 21st, when our very shortest days would yield only half an hour or so sparetime-sunlight before and after business. But this would not really be as bad as it looks because, strictly speaking, we get more light than that. We have the dawn in the morning and the twilight in the evening, covering the periods during which the sun is in position to give us the benefit of the indirect light caused by the reflection from our atmosphere. Were it not for the atmosphere, total darkness would envelop us from the moment the sun disappears below the horizon in the West until he shows up again above the horizon in the East next morning. In other words, from sunset to sunrise would be a period of total darkness. The atmosphere, however, makes the transition from darkness to light a gradual process called "dawn" in the morning, and in the same way allows day to fade into night slowly and by degrees as "twilight." These periods are both indicated on the chart, which shows that this partial light continues from about an hour and a half in December to about two hours in June. It really does not count for very much in our latitude compared with more northerly countries where the angle of the sun is more oblique and the atmosphere therefore considerably longer under the sun's influence. In England, for instance, some 15 degrees farther north than we are, there is no total darkness at all during the months of June and July. It is not an uncommon thing to see golfers in Scotland setting out for a game about 9 o'clock in the evening, whereas in this country we never can see well enough to play any outdoor game after 8 o'clock, and then only for a few days. The nights swell out very rapidly after the first half of July in this country, and by the end of August darkness overtakes us at the dinner table.

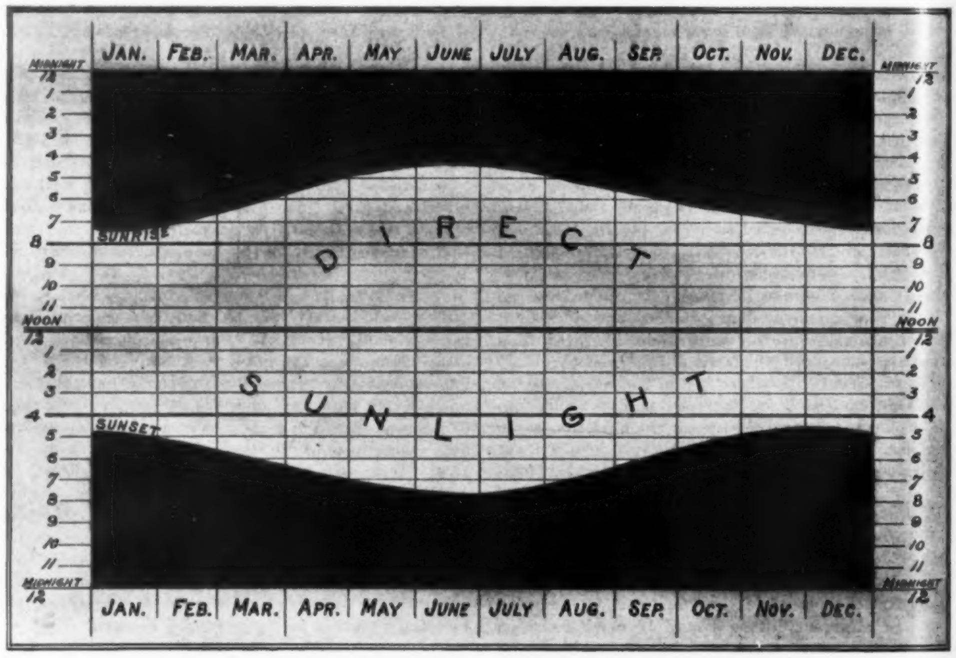



**Diagram showing portions of the day having full and twilight illumination.**

All the more reason then that we in this country should try to do something for ourselves by way of getting more benefit from the daylight we have. We are a nation of dyspeptics, and one of the reasons is that we don't exercise enough, we don't play enough. If we had more spare time in the open air we would undoubtedly improve both in health and disposition. One hour a day would mean more golf, more tennis, more croquet, more cricket, more fishing, or more whatever we choose, and certainly always more oxygen and more health. And that is what makes a better man, a happier family, a greater nation.

The best time to try the proposed experiment would be June 1st, 1914, as that is the day on which the transportation companies are in the habit of changing their running schedules, and the additional corrections required to fit the new business day of 8 to 4 could be handled very easily at the same time. Then, as it happens, June 1st, 1914, falls on a Monday, which has the additional advantage of being the beginning of the

business week, when the change can be launched most satisfactorily. Also at that time of year the long summer days are with us, when we can rely on 15 hours sunshine a day for two months or so, roughly from 4:30 A. M. to 7:30 P. M., giving us 3½ hours daylight before starting work at 8 o'clock and 3½ hours after we quit at 4 o'clock. In this way we would start right in at the time best suited to test the value of the scheme; the months of June, July and August being the period from which most benefit would accrue. Some time before that date, therefore, the plan would be to issue a proclamation from Washington requiring opening and closing time to be advanced by one hour on and after Monday June 1st, 1914, all over the country alike in factories, stores, markets, exchanges, offices, schools, churches, theaters, hotels, restaurants, and notifying transportation companies that in view of the change they would require to adjust their schedules to accommodate the resulting variations in traveling hours. As two months would seem to be ample official notice of the change, the proposed proclamation should be issued around April 1st, 1914, and before then there is plenty of time to canvass the situation and get the feeling of the community as to the merits and feasibility of the scheme.

# Man as a Source of Mechanical Power*

## His Efficiency in Different Attitudes and With Varying Loads

By Dr. A. Lanick

Many persons hold so exalted a view of the dignity of manhood that they resent, as an insult, any comparison between men and machines. But despite the ever increasing substitution of mechanical for manual labor, men still serve as machines in many industries. results form a fair measure of the average efficiency of men in general. The experiments also show the advantages and disadvantages of the various methods employed. The students ranged in weight from 120 to 198 pounds, and in height from 5 feet 3 inches to 5 feet

Comparing all of these experiments, we see that the greatest traction, 187.7 pounds, was obtained by pulling backward on a cross-bar attached to the rope, and the smallest, 90.6 pounds (less than half the greatest traction) by walking forward with the rope over one shoulder.

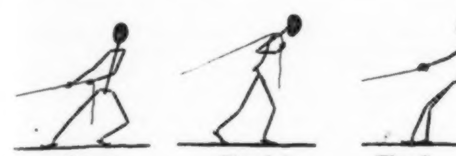


Fig. 1. Fig. 2. Fig. 3.
Three ways of pulling a rope.

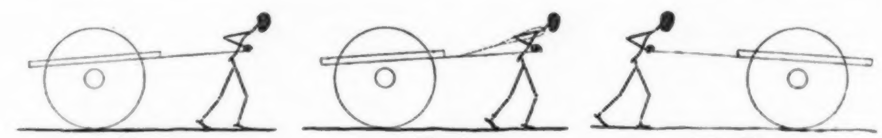


Fig. 8. Fig. 9. Fig. 10.
Moving a fire-engine with shafts connected by a cross-bar.

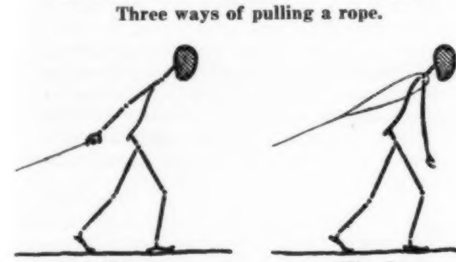


Fig. 4. Fig. 5.
Pulling a rope with the hands and by means of a loop round the shoulders.

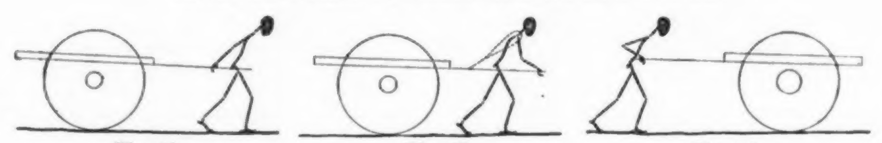


Fig. 11. Fig. 12. Fig. 13.
Moving a hand-cart with open shafts.

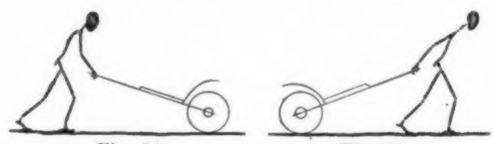


Fig. 14. Fig. 15.
Pushing and pulling a wheelbarrow.

Fig. 6. Fig. 7.
Pulling backward with the loop in two positions.

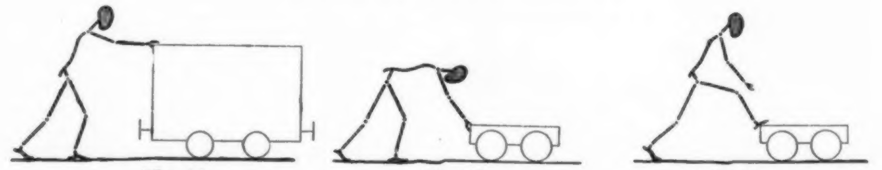


Fig. 16. Fig. 17. Fig. 18.
Moving a low four-wheeled truck, loaded and empty.

We are still far from the day when men shall be valued exclusively for their mental ability, without regard to their physical strength, and the period of transition has developed a type lower than even the human machine, namely, the human automaton, who makes the same automatic, mechanical movements day after day, and year after year, through life. Such a man is not even a machine; he has sunk to the level of the slave of a machine. We may, however, console ourselves with the hope that this is only a transitory condition, for human nature revolts at the thought of such degradation.

This article deals solely with man's physical powers and their utilization. It is interesting to learn what a man can accomplish by the strength of his muscles, and in what way he can work to the best advantage. The article is based upon researches made by Prof. Max Ringelmann, of the Institut National Agronomique in Paris, and published in the annals of that institution. The statements given represent average values, for no two men are exactly alike in muscular strength, endurance, size, weight and anatomical structure. The power of a man cannot be computed by a simple formula, as the power of a steam engine can be calculated from the steam pressure, area of piston, and length of stroke. Furthermore, a man can convert his power into work in many different ways: by pushing, pulling, lifting, pressing, turning, etc., each of which brings different muscles into action and produces a different result.

We shall here discuss and illustrate only the various ways of transporting a load. The experiments were made with about twenty students, each of whom performed the same tasks in the same conditions, so that the mean 11 inches, so that they fairly represent the average.

In order to determine the pull that a man can exert on a rope, a self registering dynamometer was attached to a rope about 16 feet long. In the first experiment (Fig. 1) the man faced the rope, and grasped it with both hands. In the second experiment (Fig. 2) he took the rope over his shoulder, grasped its pendent end, and exerted the pull by walking forward. The maximum tractive effort developed averaged, for all the men employed, 138.4 pounds in the first case, and only 90.6 pounds in the second case. This surprising discrepancy is partly due to the firmer foothold obtained in the first position, and also to the painful pressure which the rope, despite the interposition of a pad, exerted on the shoulder in the second position.

A short wooden bar was now attached, by its middle, to the end of the rope. The man grasped this bar with both hands and exerted the pull by walking backward (Fig. 3) or forward (Fig. 4). Again there appeared a striking difference in the tractive effort developed, which averaged 187.7 pounds for backward motion and only 126.9 pounds for forward motion. The superiority of the backward pull may be ascribed to the firm hold of the heels on the ground and the fact that the man's body in this position acts by its weight as well as by its muscular effort.

In the next two experiments, the end of the rope was formed into a loop, which was put around the shoulders, and the pull was exerted by walking forward (Fig. 5) or backward (Fig. 6). The traction developed was 122.6 pounds in forward motion, and 135.5 pounds in backward motion. A still stronger pull, 152.3 pounds, was produced by walking backward with the rope slung round the loins (Fig. 7).

The next experiments were made with a two-wheeled fire-engine, provided with shafts connected by a terminal cross-bar. This bar was grasped and pushed with the hands, and was kept at the proper level by loading it with a weight of 40.7 pounds. When the man walked in front of the vehicle and behind the bar (Fig. 8) he exerted a traction of 183.7 pounds, and when he also employed a breast-strap attached to the shafts (Fig. 9) the traction was increased to 187.9 pounds. By pushing the vehicle before him (Fig. 10), although the weight attached to the bar was reduced to 18.7 pounds, he could exert a useful effort of only 123.0 pounds.

In another series of experiments, a small hand cart with open shafts was used. It was proved that a man could exert a traction of 145.3 pounds by grasping each shaft with one hand and drawing the cart after him, as he walked forward (Fig. 11). The force exerted was increased to 152.6 pounds by adding the breast-strap (Fig. 12), but it fell to 88.0 pounds when the man pushed the cart before him (Fig. 13). These results are very inferior to those obtained with the fire-engine, largely for the reason that the hand and arm must be twisted through 90 degrees in order to grasp the longitudinal shaft of the cart, and therefore work to less advantage than in grasping the cross-bar of the fire-engine.

For the same reason no very good results can be expected in the use of the common wheelbarrow. Here, also, the efficiency is less when the barrow is pushed (Fig. 14) than when it is pulled (Fig. 15), but the pushing method is usually practised because it gives the man better control of the barrow, and lessens the risk of overturning.

Another series of experiments was made with a low four-wheeled truck, without shafts or handle. When the

*Translated for the Scientific American Supplement from Kosmos.

truck was laden with a box or bale high enough to allow a man to push against it, without stooping or lowering his arms (Fig. 16), a useful effort of 136.9 pounds was exerted, but this was reduced to 110.0 pounds when the man was compelled to bend low in order to push the truck (Fig. 17). Empty trucks of this sort are often pushed with the foot (Fig. 18), in which case the useful effort exerted falls to 84.3 pounds. These experiments show the advantage of providing such trucks with handles as high as a man's breast.

We have now obtained a clear picture of the amount of work that one man can accomplish in transporting loads by various methods. It is an interesting and curious fact that this amount of work is lessened considerably when two or more men are attached to a single rope or vehicle. When two men hauled the fire-engine (Fig. 8), for example, the tractive effort developed by each man was about 20 pounds less than it was when he worked alone. The lack of synchronism in the movements of two or more men working together has been suggested as the cause of this discrepancy, but this explanation is not sufficient, for the same phenomenon is observed in coupled inanimate motors. When two cylinders, each capable of producing 100 foot-pounds of work per second, are coupled, the total work produced in one second is only 170 foot-pounds, or 85 foot-pounds for each cylinder. The work of each cylinder per second falls to 75 foot-pounds when four cylinders are associated, and it continues to diminish as the number of cylinders is increased.

Similarly, if we denote by 100 the pull that one man can exert on a rope, two such men pulling on the same rope can exert a pull of only 186, or 93 for each man. The force of the individual pull sinks to 85 for three men, and to 49 for eight men, pulling together on one rope.

A man therefore works to the best advantage when he works alone. We are here considering purely physical labor. Whether or not a similar law applies to mental work would be difficult to prove, but in an age when men are so largely employed as sources of mechanical power, the experiments described above possess great interest and value, as they show the employer of labor how that labor can be utilized to the best advantage, and enable him to discover if his men work unprofitably, or needlessly fatigue themselves. But it is to the interest of the workman, also, to know how he can best employ his power, so that he can perform his task most efficiently and preserve his health and strength.

# Rust-Proofing Iron and Steel Articles*

## Processes Based on the Formation of An Oxide Coating

By Emmanuel L. Blassett, Jr.

One of the greatest metallurgical problems of the day has been to produce a non-corrosive surface on iron and steel by chemical or electrochemical methods. The application of enamel, japan, paint, varnish and bronze powders to iron and steel surfaces, to prevent corrosion, is widely practised. It seems to solve the problem for certain articles, and a description of these methods does not come within the scope of this paper. The real modern problem has been to produce a rust-proof finish that would not obliterate or obscure the minute outlines of the article treated. Furthermore, the ideal process should not destroy the physical properties of the metal, such as its temper and resilience. That the finish should be dark or black in color has also been found desirable in many instances. Nickel has for many years been used as a decorative and non-corrosive coating for iron and steel, but has not proved efficacious or durable enough in this respect. All electro-deposits are apt to wear through in a short time on the edges of plated goods, and when this happens, oxidation rapidly takes place and the rust becoming lodged underneath the deposit soon forces it off. This would not be the case with a finish produced by the latest Bower-Barff process, or by Coslettizing, for the reason that the surface of the metal treated is converted to the black oxide of iron or phosphate of iron. Hot galvanizing has long proved to be a very good protection against corrosion, but its application is very limited owing to its poor appearance and the impossibility of using the process for many articles in ordinary use.

Within the last decade many skilled chemists and metallurgists have sought to discover a chemical or electrochemical process that would protect iron and steel from corrosion, with the result that several new methods have come into industrial use. The processes now in use consist in converting the surface of the article treated to the black oxide of iron, or the phosphate of iron. Further experimenting may result in discovering other iron compounds that may prove equally rust-proof.

### BLACK OXIDE OF IRON.

The production of the black oxide of iron ($Fe_3O_4$) on the surface of iron and steel, to prevent corrosion, has been practised for many years and is the oldest of the purely chemical methods. The fact that iron became coated with the black oxide when treated with superheated steam was undoubtedly noticed at an early date. Prof. Barff was the first to seek to apply the principle industrially, but it has remained for later investigators to perfect the methods of producing the black oxide so that it may be used extensively as a commercial finish. There are three processes for producing the black oxide in use at the present time, known as the Bradley rust-proofing process, the Bontempi process and the cold process, the latter being used especially on edge tools. When the surface of iron and steel has been converted to the black oxide, corrosion ceases, as no more oxygen can be taken up by the iron. For this reason it forms an ideal rust-proof coating for the underlying metal.

All processes, based upon the use of excessive heat, for producing the black oxide of iron must necessarily have a limited application. Such methods, for instance, cannot be used for finishing edge tools, as the temper would be destroyed. Articles are also enlarged by heating, and measuring instruments and work of delicate design or figures cannot be treated. The black produced by excessive heat is also considered too heavy for some articles, as too great amount of the surface is converted to the black oxide. For edge tools, measuring instruments and articles of delicate design the cold process for producing the black oxide should be used.

### BOWER-BARFF PROCESS.

The original process for producing the black oxide of iron by heating the surface of iron to a red heat dates from the year 1876. In that year Frederick S. Barff was granted a patent in England for an "Improvement in Processes for Protecting Iron Surfaces." The original methods employed by Barff and his immediate successors have been greatly improved upon, and a brief historical survey of this process will prove interesting. In the Barff process the articles to be treated were heated to a red heat in a closed vessel, followed by the injection of superheated steam. In the year 1880 George and Anthony S. Bower were granted a patent in England and the United States on a method for "Coating Iron with Oxide." This method consisted of heating the article to be treated in an atmosphere of carbon dioxide instead of steam. This process was based on the well-known chemical fact that when iron is heated to a red heat with carbon dioxide it will reduce the carbon dioxide to carbon monoxide, and the iron itself is converted to the black oxide. Much difficulty was encountered in using both of these methods, and the oxide was apt to scale off and be without uniformity. Several improvements made by George W. Gesner of Brooklyn, in the year 1888, were the next step in the development of this interesting process. Gesner's modification consisted in introducing a hydrocarbon, such as naphtha, with the steam. The black oxide produced by the Gesner method contained hydrogen, which rendered it less liable to scale. Gesner also improved the furnace for producing this finish. All these early methods had one great disadvantage in industrial operation. Uniformity was not always possible, and the red oxide, or ordinary iron rust, was frequently formed simultaneously with the black oxide. The latest improvement in this process was made in the year 1908 by John J. Bradley of Brooklyn, and is known as the

### BRADLEY RUST-PROOFING PROCESS.[1]

The improved process introduced by Mr. Bradley was patented by him in 1908. By his method a more durable and uniform finish is produced, and what is of still more importance, the red oxide is not formed. It is interesting to note that Mr. Bradley collaborated with Gesner while the latter was conducting his experiments in producing this finish. By the Bradley process the articles are heated to a red heat in a muffle and hydrogen gas is then introduced. Gasoline in small quantities is also passed in in order to improve the color of the coating. The ordinary muffle furnace is operated and coke is used for fuel. To produce an even finish the article to be treated is first cleaned by tumbling, pickling or sand blasting. Sand blasting is preferred, as it leaves the surface of the article in a more suitable condition for producing the finish. The articles are left in the furnace for an hour or until a sufficiently heavy coating of the black oxide is produced. They are then taken out and allowed to cool and finally oiled with linseed or paraffine oil. The oiling improves the color for decorative purposes. Steel, malleable iron or cast iron may be treated by this method, and the coating produced is very impervious to the action of the atmosphere.

### THE BONTEMPI PROCESS.[2]

The Bontempi rust-proofing process, patented a few years ago, may also be considered as a modification or improvement on the original Bower-Barff process. The Bontempi process consists in heating the article as in the Bradley process and then passing in steam and the fumes of zinc or some heavy hydrocarbon, such as tar or pitch. A very heavy oxide is produced, depending upon the length of time the article is treated. The finish is invariably uniform and of a deep black color. It is claimed to withstand corrosion for an indefinite time. Augusto Bontempi of the Bontempi Company, has recently improved the process and obtained a patent for the use of various substances, claimed to accelerate the formation of the black oxide. As in the Bradley process, a muffle furnace is employed and the articles are heated to 900 deg. Fahr. or more.

### COLD PROCESS FOR PRODUCING THE BLACK OXIDE.

The cold process for producing the black oxide of iron can be used with facility on a large variety of goods. It is especially adapted for refinishing edge tools and general hardware. Although it is used extensively at the present time, it is most likely to be discarded for more simpler and economical methods, and "coslettizing" or some such process may supplant it. There seems to be no record of the origin of this process, but it is known to have been used for many years, especially for finishing gun barrels. The black oxide produced by the cold process is much lighter than that produced by heating in a furnace and is not considered so highly resistant to the corrosive action of the atmosphere. The cold process produces a smooth and full black coating which does not scale off and is considered sufficiently rust-proof for a large variety of goods.

The process has been described by "Ionic" in *The Metal Industry* for October, 1910, and only a brief description of the process will be given here. The article should be cleaned as if for plating, after which it is coated over with a solution composed as follows:

| | |
|---|---|
| Water | 4 ounces |
| Alcohol | 4 ounces |
| Ferric chloride | ½ ounce |

The solution is applied with a sponge to the article to be treated; care should be taken that the sponge is well squeezed out before applying it to the work. Too much solution in the sponge will not produce the desired results. The articles are then placed in a warm, moist atmosphere. For this purpose a chamber heated by steam is employed and the exhaust from the steam coil produces the necessary moisture. The articles are steamed for 45 minutes, when they are removed from the chamber and immersed in clean, boiling water for 15 minutes. After removing from the water bath and cooled, the work is scratch-brushed on a fine wire wheel brush revolving at about 600 revolutions per minute. To obtain a good and durable black oxide, it is necessary to sponge the work with the solution previously given two or three times, followed by steaming, hot water treatment and scratch-brushing as in the first operation. After the final scratch-brushing the articles are oiled with linseed oil and carefully wiped with a cloth. The oil should always be applied, as it improves and deepens the color and makes the work still more rust-proof. Anyone interested in this process should obtain a copy of *The Metal Industry* for October, 1910, wherein a complete and adequate description of the process is given.

There are several modifications of this process in which more complicated solutions are employed, but the results are not any better and are usually more expensive to operate, requiring more labor and attention. The following formula is said to be used extensively on Swiss watches and novelties made of steel and iron:

* From *The Metal Industry*.

[1] *The Metal Industry*, January, 1912.

[2] Bontempi Rust Proof Company, Bridgeport, Conn. *The Metal Industry*, May, 1912.

| | Grammes. |
|---|---|
| Nitric acid | 27.0 |
| Hydrochloric acid | 7.5 |
| Copper sulphate | 7.5 |
| Ferric chloride | 333.5 |
| Water | 2,000.0 |

The articles are sponged as previously described and placed in a drying chamber heated to about 100 deg. Fahr. for 20 minutes. The work is then steamed in a separate compartment for a half hour or more and again dried in the drying chamber for 20 minutes, when the work should be coated with ordinary iron rust. The articles should then be immersed in clean, boiling water for 20 minutes, and after being allowed to cool are scratch-brushed. These operations as in the process previously described are repeated three times, or until a suitable black is obtained. This process is said to be extensively used in Europe, but it seems to be more expensive in operation and the results are the same as in the cold process previously given.

OTHER METHODS FOR PRODUCING THE BLACK OXIDE.

There are various other methods for producing the black oxide of iron. It may be produced by immersing the iron or steel article in molten niter (nitrate of potassium or saltpeter) or nitrate of sodium (Chile saltpeter). This is known as steel bluing, and is used extensively on a large variety of articles. The color may be blue or black, depending upon the length of time the article is immersed and the degree of heat employed. Small articles, such as steel buttons and buckles, may be given a black finish by tumbling in a sheet-iron barrel heated to the right temperature by means of a gas furnace. This is the usual method for finishing iron and steel novelty work requiring a black finish. Heating the articles in charcoal also produces a blue or black oxide, and the process is extensively used on revolvers and general hardware. These methods, however, do not produce a finish that can be considered rust-proof. The oxide formed is too light and corrosion is not retarded to any great extent.

COSLETTIZING.

The method known as coslettizing is very simple and economical to operate and may be regarded as the most advanced step in rust-proofing iron and steel. It is the ideal process for general work. Coslettizing consists of producing upon the iron or steel article a coating of phosphate of iron ($Fe_3PO_4$), which is quite impervious to the action of the atmosphere. This process was discovered by Thomas W. Coslett, an analytical chemist of Birmingham, England. The process was patented in England in 1906 and in the United States in the following year. The process was described by the writer in *The Metal Industry* for May, 1911, and its extensive application since that time merits further attention. It is now extensively used on typewriter parts, harness trimmings and general hardware. There is a very wide field for the application of this process, and articles of the most delicate nature may be treated without injury. This method does not destroy the physical properties of the metal treated, and articles are not perceptibly enlarged as in the heat process. Such articles as watch springs and micrometers have been successfully treated by this method.

The solution for coslettizing is made as follows:

| | |
|---|---|
| Concentrated phosphoric acid | ½ gallon |
| Water | ½ gallon |
| Iron filings | 2 pounds |

When the iron is thoroughly dissolved, this solution is added to 50 gallons of water. A wrought iron tank is necessary to hold the solution, which should be heated close to the boiling point by a gas stove or a steam coil. If desired, the tank may be encased in brick work and wood or coal may be employed as fuel.

The work to be treated by this method is first cleaned as if for plating. If necessary it should be pickled in the usual muriatic dip to remove the rust. The work is suspended in the solution by means of iron wire or hooks; small articles, such as screws or bolts, are placed in iron or earthenware baskets. The solution must be kept close to the boiling point, and the work is allowed to remain in it from one half hour to three hours, depending upon the nature of the work or the thickness of the coating required. This process produces the most rust-resisting finish for iron and steel by simple immersion in solution that has yet been discovered. A very slight amount of the surface of the article is converted to the phosphate of iron, but most of the coating comes from the solution itself. When the solution is working properly, a heavy coating is produced in two or three hours. A convenient arrangement for a small bath is to make up the solution in an enamel or agate-ware tank and heated by placing it in boiling water. A wooden tank may be used for holding the water, which should be kept hot by a steam coil.

When the work is removed from the solution it should be allowed to dry in the air; rinsing in hot water is unnecessary. If the work treated is to be used for ornamental purposes it should be scratch-brushed on a fine wire-wheel brush revolving about 600 revolutions per minute. The finish is much improved by oiling with linseed or paraffine oil.

The licensees of this process are given a chemical test worked out by the inventor, which indicates the conditions of the solution and the proper density to maintain it. The manufacturers who are using this process speak very highly of it. Typewriter manufacturers use it on work that is finally japanned and claim that it retards corrosion to a remarkable degree on typewriters used in torrid climates or on vessels. If the body of the typewriter is not coslettized, the rust eats through the japan much sooner. The inventor of this process has recently patented a new formula for coslettizing, which contains zinc and is made up as follows:

| | |
|---|---|
| Zinc | 6 ounces |
| Phosphoric acid | 1 pint |
| Water | 1 pint |

This is the "stock" solution which should be used in portions of 1 ounce to each gallon of water. An interesting modification of this process was recently patented by F. R. G. Richards of Coventry, England. The formula is as follows:

| | |
|---|---|
| Water | 1 gallon |
| Manganese dioxide | 3 pounds |
| Phosphoric acid | ½ pound |

The English courts declared this formula an infringement on Mr. Coslett's process, and the patentee is barred from introducing it. Coslettizing has now become a firmly established industry, and in the future it will be used extensively on general hardware.

ELECTROCHEMICAL METHODS FOR RUST-PROOFING.

Electrogalvanizing is unquestionably the most durable and practical rust-proof finish that can be produced by electrodeposition. The work to be rust-proofed should be given a heavy deposit so that it may not be readily worn off by friction. The solution usually employed is composed as follows:

| | |
|---|---|
| Zinc sulphate | 2 pounds |
| Aluminium sulphate | 2 ounces |
| Water | 1 gallon |

A good heavy deposit of brass, copper or nickel on steel and iron retards corrosion for a considerable time and these methods are too well known to describe here. Black nickeling seems to be the only method for producing a black finish directly on iron and steel by deposition that is fairly rust-proof. To produce a black nickel deposit the following formula is generally used:

| | |
|---|---|
| Double sulphate of nickel and ammonium | 10 ounces |
| Zinc sulphate | 1 ounce |
| Sulphocyanide of potash | 2 ounces |

Black nickel deposits should be lacquered or oiled to still further retard corrosion or prevent staining.

Another method that produces a black finish on iron and steel by the use of the electric current is as follows:

| | |
|---|---|
| Lead nitrate | 12 ounces |
| Ammonium sulphate | 8 ounces |
| Water | 1 gallon |

The articles to be colored are hung on the positive or anode rod. For a cathode, sheet steel may be used. This solution merely colors the work treated, and the finish should be oiled or lacquered, when it will keep from rusting for a certain time. The rust-proofing of iron and steel articles by chemical or electrochemical methods is still capable of further development, and the future, no doubt, will see new processes come into industrial use.

## By-Products from Non-Coking Coals*

There are many colliery companies in England the proprietors of which would erect by-product coke ovens if their coals were suitable. Much money has been spent on experimental work, but it has not been found practicable to manufacture metallurgical coke from coal which, under normal conditions, is non-coking, although they are frequently much richer in by-products than many coking coals, so it is particularly unfortunate they cannot be utilized in by-product ovens. However, it is not outside the bounds of possibility to use non-coking coals in processes in which the by-products are recovered. At present two principal alternatives present themselves: (1) Processes of low temperature carbonization, producing smokeless fuel; and (2) the adoption of a producer gas plant working in conjunction with a recovery system. A combination of these two is almost ideal, and the proposition outlined below should be worth the attention of coal owners.

Any process involving the decomposition of coal also involves the production of gas, either in the form of rich gas of 400 to 600 B.t.u., or of producer gas, of a calorific value of 130 to 160 B.t.u. In most cases some use must be made of this gas, for only in exceptional cases can the makers afford to waste it. In a scheme proposed in South Africa, where a large producer plant is to be erected, the coal is so cheap and so rich in nitrogen that it is a paying proposition to work the coal for the sulphate of ammonia.

In general, collieries require quite an appreciable amount of power, and all requirements in this respect could easily be met. Gas-fired boilers, large gas engines and gas turbines, have reached a high state of efficiency, and it might be possible in some cases to dispose of surplus gas to electrical companies, as in the case of the Old Silkstone Colliery Company of Barnsley selling coke oven gas to the Yorkshire Electric Power Company for boiler firing.

As suggested, the ideal combination is of low-temperature carbonization with gas producers working under recovery conditions. Plants for low-temperature carbonization have been before the public very much of late, and although very extravagant claims have been made on their behalf, some of the processes are now sufficiently well developed to warrant their adoption on a commercial scale. Several plants are under erection at the present time, and very stringent guarantees have been given by the builders. For the gas producer portion several well-tried processes of such nature are on the market, successful beyond question.

It might be interesting to consider what could be done with such a plant handling, say, 1,000 tons of coal per week. Next to a coking coal, the best coal for the purpose is one not absolutely non-coking, but that has sufficient of the coking property to form a soft coke. It should be fairly free from sulphur and should contain not more than 8 to 10 per cent of ash. The type of retort heated by a portion of the gas evolved from the coal is perhaps the most suitable for the purpose. The gas would first be denuded of its tar and ammonia, and then washed in creosote oil to extract the benzol, and, if necessary, compressed to extract the whole of the light oils. The yields which might reasonably be expected from a typical Midland coal are as follows:

| | |
|---|---|
| Coke | 65-70 per cent |
| Tar | 6-8 per cent |
| Benzol and light oils | 2-4 gallons per ton |
| Sulphate of ammonia | 15-25 pounds per ton |
| Surplus gas | 1,000-2,000 cubic feet per ton |

The coke produced would be the smokeless fuel so frequently heard of nowadays. It would not, however, be much of an asset to colliery companies, as a market for it would have to be cultivated. It is very doubtful, too, if the fancy prices expected in some quarters would be realized.

The coke would, in the present proposal, be utilized in gas producers. On an average, it should yield from 60 to 90 pounds of sulphate of ammonia per ton, and some tar; 650 to 700 tons of the coke would be available per week for gasification in producers; and, taking an average yield of 70 pounds of sulphate of ammonia, there would be 45,500 to 49,000 pounds, or, say, 20 tons per week. It is hardly advisable to put down a producer plant with by-product recovery with a capacity of less than 500 tons per week; and, of course, the cost per ton gasified, both capital and maintenance, would decrease as the capacity of the plant was increased.

Roughly, 100,000 cubic feet of producer gas is obtained from a ton of fuel under recovery conditions, so that the weekly yield would be approximately 65,000,000 cubic feet of a calorific value of about 140 B.t.u. In producer gas practice none of this gas is actually necessary for working the plant, but steam is required, and the gas can be employed for boiler firing, and all the steam required obtained without extra fuel cost. It is advantageous to operate some portions of the machinery by electricity. For this purpose producer gas is best utilized in gas engines, and if there is any possibility of the sale of surplus power large gas engine plants could be put down.

The scheme outlined is well within the bounds of possibility. There are already large producer plants in successful operation, and the tendency of colliery owners is in the direction suggested. There is a rapidly increasing demand for all the products obtainable from coal, and the prices realized leave a substantial margin of profit. Moreover, the market for all these products seems more than likely to go on increasing; and it is not reasonable to expect that their supply can continue to be limited by the demand for metallurgical coke.

* From the *Gas World*, London, England.

**Necessity of Weight Reduction.**—The problem of the future, in so far as the automobile world is concerned, would seem to be one concerning the reduction of weight. There can be no gain-saying the fact that motors have been brought to a wonderful state of perfection and efficiency; that bodies are more comfortable than ever in the past and that control leaves little to be desired. But most of these perfections have added weight to the chassis, already heavy, in a great many cases. Fuel economy, tire economy and the reduction of wear and tear on the vehicle demands that lightness be kept paramount in the mind of the designer. We can increase efficiency by the not altogether simple expedient of reducing weight. But it would seem that a serious attempt at cutting down weight still further would be well worth the attempt.

## NEW BOOKS, ETC.

PHOTO-ELECTRICITY. The Liberation of Electrons by Light. With Chapters on Fluorescence and Phosphorescence, and Photo-Chemical Actions and Photography. By H. Stanley Allen, M.A., D.Sc. New York: Longmans, Green & Co., 1913. 8vo.; 221 pp.; with diagrams. Price, $2.10 net.

Since the second edition of Sir J. J. Thomson's "The Conduction of Electricity Through Gases," English publications on the subject of photo-electricity have been wanting. Dr. Allen's monograph fills the void by sketching the later history of the subject and incorporating the experimental results of the past seven years. The problems embodied are of practical as well as theoretical interest, for they are related to photo-chemical processes of all kinds. As indicative of the scope of the work, we may mention among the more important chapters those on the photo-electric substances—solids and liquids, gases and vapors; the influences of temperature and of the character of light on the discharge; photo-electric fatigue; and photo-chemical actions in their relati ms to photography. The fruits of long, painstaking research are made accessible to students and to the reading public, and little of value, from the first observations of Hertz to the more advanced knowledge of to-day, has been overlooked. As a distinct contribution to the literature of an obscure subject, the monograph should be enthusiastically received.

MY VOYAGE IN THE UNITED STATES FRIGATE "CONGRESS." By Elizabeth Douglas Van Denburgh. New York: Desmond FitzGerald, Inc., 1913. 8vo.; 338 pp.; illustrated.

All the officers, and presumably all the crew, of this voyage of the "Congress" are dead, and of the twelve passengers, Mrs. Van Denburgh and her sister alone survive. Their father, Joel Turrill, received the appointment of United States Consul-General to the Sandwich Islands, under James K. Polk, and with his family was conveyed to his post by the "Congress." Mrs. Van Denburgh's account of the voyage is full of simple detail, and pleases by its very sincerity and lack of ornament, though prominent names appear in the narrative. An albatross caught with hook and line; decks cleared for action upon sight of a vessel which turned out to be an innocent whaler; the sinister companionship of a shark; some rough weather—these are the enlivenments of the passage. There are glimpses of the world of red-tape and officialdom, and others of life in Honolulu. The journal ends with the departure of the "Congress" from the harbor.

POSITIVE RAYS OF ELECTRICITY AND THEIR APPLICATION TO CHEMICAL ANALYSIS. By Sir J. J. Thomson, O.M., F.R.S. New York: Longmans, Green & Co., 1913. 8vo.; 132 pp.; illustrated. Price, $1.40 net.

In this monograph, Sir J. J. Thomson chronicles the Cavendish Laboratory experiments with positive rays, also touching upon the Döppler effect, and Gehrcke and Reichenheim's experiments on anode rays. He urges a general application of the positive rays to chemical analysis. This method is even more sensitive than that of spectral analysis; it calls for a minimum of material, and uses that material in a practically unrefined condition; and, once a high vacuum is secured, the technique of the operations is not hard to master. The work has a number of photographic plates illustrative of the magnetic and electric deflection of impinging rays; the many line drawings showing the appliances and their uses conduce to a ready grasp of the experiments and the principles they demonstrate.

THE WORLD ALMANAC AND ENCYCLOPEDIA, 1914. New York: The Press Publishing Company. Price, 25 cents; by mail, 35 cents.

The Almanac for 1914 is the same indispensable mine of popular statistics with which past years have made us familiar; but there are a number of timely and noteworthy aditions. The Monroe Doctrine is quoted in full. There is Henry George's own statement of the single tax principle. The old Tariff is given, paralleled line by line with the new. The concise information regarding the parcels post, postal savings, and the income tax, will be welcomed. Recent labor legislation is cited by States, and the platforms of the various labor organizations are presented. The Panama Canal act, the pure food law, the civil service, railroads, immigration, industry—all are the subjects of incisive articles or instructive tables. The investor, the public speaker, the sportsman, the churchman, the voter, the general reader, each may turn to this compendium with full confidence of finding there something pertinent to his pursuits and interests.

THE MODERN WARSHIP. By Edward L. Atwood. Cambridge: The University Press. New York: G. P. Putnam's Sons, 1913.

Even well-informed people have but a very vague conception of the complexity of a modern warship. How a great battleship is designed, how her hull is constructed, how her armor is rolled and applied, how the details of her armament are thought out, how she is prevented from sinking when a torpedo strikes her, how she is maneuvered—all these things and many more are not commonly known. Mr. Atwood, in the little book which lies before us, has presented in a very compact and readable form all that an ordinary man should know of warship construction.

THE INDIVIDUAL IN THE ANIMAL KINGDOM. By Julian S. Huntley, B.A. Cambridge: The University Press. New York: G. P. Putnam's Sons.

The task which the author has attempted, as he states in his preface, is a two-fold one. He has tried to frame a general definition of the individual which will be sufficiently objective to permit of its application by the man of science, but which at the same time will be admitted as accurate (though perhaps regarded as incomplete) by the philosopher. He has tried to show in what ways individuality, as thus defined by him, manifests itself in the animal kingdom. Although much Bergsonian philosophy is reflected in this book, although the views expressed are extremely personal at times, the book is most stimulating; it provides exactly the kind of reading that a thoughtful man enjoys.

AERO-MANUEL 1914. Repertoire sportit, technique et commercial de l'Aeronautique. Par Ch. Faroux, ingénieur, ancien élève de l'Ecole Polytechnique, rédacteur en chef de "La Vie Automobile," et G. Bonnet, redacteur a la rubrique aeronautique de "L'Auto." *3e edition.* In-8º raisin (16×25) de 870 pages avec nombreuses figures. Prix, 12 francs. H. Dunod et E. Pinat, Editeurs, 47 et 49 Quai des Grands-Augustins, Paris, VIº.

The Aero Manuel is neither a purely commercial annual nor a collection of popularly presented information on aeronautics. Its authors felt themselves constrained to present, in a handy form, all the more desirable information on the sporting, manufacturing, and industrial side of aeronautics. Hence the work is divided into three great divisions—sport, technic and industry, the one merging more or less into the other. In the first part will be found in condensed form the leading facts relating to the history of aeronautics and aviation; the second part is a simple *vade-mecum*, which is limited to definitions and essential explanations, characteristic descriptions, short technical notes and practical tables. In the third part, the field of automobile mechanics is invaded, an invasion which the publishers promise to make somewhat more complete in future editions, all the more so since there is an undeniable connection between the automobile and aeronautics. The commercial and sporting industrial annual which constitutes the fourth part of the volume is a very complete review of the aeronautic industry. The volume may be commended to builders and those who are interested in aeronautics in general.

THE OFFICIAL GUIDE TO THE GREAT WESTERN RAILWAY. Express Routes to the West of England, the Channel Islands, South Wales and Ireland, the Midland Counties and North Wales, Lancashire, Yorkshire and the North. 12mo.; 472 pp.; illustrated with maps and plans. New York: Cassell & Co., Ltd., 1913.

The Great Western Railway of England serves nineteen counties and a great part of the Welsh principality. Americans are met at the steamer by its representatives, and the tourist is sure to make one of the hundred million passengers that annually travel upon its three thousand miles of permanent way. This official guide supplements the time tables, and contains 71 maps and plans, many illustrations and an index. Its concise information about routes, towns and trains is just what the tourist needs to alleviate the many little worries and bewilderments of travel.

FOOD AND FEEDING. By Sir Henry Thompson, Bart., F.R.C.S., M.B. New York: Frederick Warne & Co. 12mo.; 320 pp. Price, $1.35 net.

Our distinguished author bases his specifications of man's food requirements on climatic conditions, citing those modifications of the dietary found in races of the torrid, temperate and frigid zones. While advocating the mixed diet, he admits that in some circumstances and with certain individuals vegetarianism, or at least restricted variety, may be beneficial He maintains that even exercise may be largely dispensed with if the foods be suited to sedentary demands and the nitrogenous elements limited. In the course of his arguments the vegetarian is given some hard nuts to crack. For example, it is pointed out that man is born into the world a consumer of animal food, and it is difficult logically to maintain that at some stage in his development he should confine his appetite to the products of the vegetable kingdom. No man, says the author, is entitled to the name "vegetarian" who includes in his menu eggs, butter, milk and cheese. The larger portion of the work is devoted to methods of preparing food for the table, as exemplified in the practices of the various nations, and is rich in suggestion to the cook and the housewife. This is a twelfth edition, and embodies Sir Henry's "last words"—the phrase is his own—on foods and feeding.

THE LOCOMOTIVE. Vol. XXIX. Hartford, Conn.: The Hartford Steam Boiler Inspection and Insurance Company. 1912–1913. 8vo.; 254 pp.; illustrated.

The quarterly issues of *The Locomotive* for the years 1912 and 1913 are here gathered together in book form, and offer some interesting reading on locomotives, boilers and allied subjects. The captions vary from gage glasses to gyroscopes. Boiler explosions and their causes take up much of the space of the volume, and unique methods of patching and repairs, the location of baffling troubles and protective procedures and devices account for most of the space remaining.

TASCHENBUCH DER LUFT-FLOTTEN. Mit besonderer Berücksichtigung der Kriegs-Luftflotten. I. Jahrgang 1914. Mit teilweiser Benützung amtlicher Quellen, herausgegeben von F. Rasch, Generalsekretär des deutschen Luftfahrer-Verbandes, und W. Hormel, Kapitänleutnant a. D. Mit 545 Bildern und Skizzen. München: J. F. Lehmann's Verlag. Preis gebunden M. 5.

This volume is intended as an aerial counterpart of the excellent "Taschenbuch der Kriegs-Flotten" of Weyer, which is annually reviewed in this column. In 1910, an attempt was made for the first time to include in Weyer's "Taschenbuch" an estimate of the aerial strength of the various powers. The statistics presented covered two pages. So rapid have been the advances made in aerial navigation by the various military powers since 1910 that there is now enough material to make up a volume fully as large as the annual "Taschenbuch der Kriegs-Flotten."

The volume opens with a list of aircraft, photographic views of the principal craft together with structural details. Silhouettes are provided which will enable anyone readily to identify the various airship types. Comparative statistics show that Germany is by far the most formidable air power. The aggregate gas capacity of the German airship fleet amounts to the formidable total of 244,100 cubic meters; of the French air fleet, 116,600; of the Italian, 71,265; of the English, 25,000; and of the Austrian, only 15,900. The United States plays no part in these comparative statistics for the simple reason that thus far Congress seems to have ignored the necessity of strengthening the aerial branch of our army.

A valuable portion of the book is that which gives the reader an idea of the military utilization of various aerial types by the different powers. To this is appended an exhaustive list of the aeroplanes owned by the principal nations.

A list of airships and aeroplane motors is added which is extremely valuable.

The book is to be welcomed as the first of a series of annual publications, the utility and value of which must unquestionably increase from year to year. The publishers and the editors are to be congratulated.

THE STORY OF A LOAF OF BREAD. By T. B. Wood, M.A., Drapers Professor of Agriculture in the University of Cambridge. Cambridge: The University Press. New York: G. P. Putnam's Sons.

Beginning with a sketch of the growing and marketing of wheat, the author takes up milling and baking. Prof. Wood is not wholly in sympathy with those who would force scientific methods on the farmer. "The farmer, especially the small farmer, spends his days in the open air, and does not feel inclined to indulge in analytical bookkeeping in the evening. Consequently, the onus of demonstrating the economy of suggested innovations in practice lies with those who make the suggestions." Prof. Wood has handled a very difficult subject in a very interesting way.

SUBMERGED FORESTS. By Clement Reid, F.R.S. Cambridge: The University Press. New York: G. P. Putnam's Sons.

The submerged forests which Mr. Reid so admirably discusses are those of England, but his observations would apply with equal force, so far as generalities are concerned, to similar American formations. Hence American readers, in our opinion, would find it worth while to read this readable, popular book.

SPIDERS. By Cecil Warburton, M.A., Christ's College. Cambridge: The University Press. New York: G. P. Putnam's Sons.

Mr. Warburton has written a very interesting book for the general reader, on the habits and modes of life of spiders, particularly those which are most frequently met with and most easily recognized. Most of the species discussed are those of the United Kingdom, but some southern varieties are also taken up. Hence American readers will find in this little book much that ought to interest them.

EARTH WORMS AND THEIR ALLIES. By Frank E. Beddard, M.A., F.R.S. Cambridge: The University Press. New York: G. P. Putnam's Sons.

This excellently written book takes up chiefly questions relating to geographical distribution, but the introductory portion is devoted to a discussion of anatomical and zoological data. Because the phenomena of distribution play such an important part, it has been possible to include in the survey nearly all the accepted genera of worms.

PLANT-ANIMALS. A Study in Symbiosis. By Frederick Keeble, Professor of Botany in University College, Reading. Cambridge: The University Press. New York: G. P. Putnam's Sons.

Besides being a popularly written book on a biological subject which is rarely discussed in a simple way—a type of book, in other words, in which an author usually seeks to present, not original discoveries, but to present in simple form the sum total of all past discoveries in the field—this excellent manual contains not a little interesting information relating to biological facts discovered by the author alone and in co-operation with Prof. Gamble. It may be recommended as a good, brief account of a very mysterious phase of biology.

THE EARTH. ITS SHAPE, SIZE, WEIGHT AND SPIN. By J. H. Poynting, Professor of Physics in the University of Birmingham. Cambridge: The University Press. New York: G. P. Putnam's Sons, 1913.

Prof. Poynting's position and reputation in the world of science is such that everything he writes is sure to command respect. It is not often that a distinguished scientist condescends to write, for the masses, a book on a subject with which his name is identified, and when he does, the result is not always what the masses expect. This little book of Prof. Poynting's, on the other hand, is a good example of what popular science ought to be. Without the aid of complicated mathematics or involved explanations, he gives the layman a very good insight into the methods employed by the astronomer in determining the shape, size, mass, and rotation of the earth.



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### Table of Contents

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